

The 'top 100' drugs and classes in England:

Audi, Selma; Burrage, Daniel R.; Lonsdale, Dagan O.; Pontefract, Sarah; Coleman, Jamie; Hitchings, Andrew W.; Baker, Emma H.

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20 **Abstract**

21

22 **Aims**

23 Prescribing is a complex skill required of doctors and, increasingly, other healthcare
24 professionals. Use of a personal formulary can help to develop this skill. In 2006-9,
25 we developed a core list of the 100 most commonly prescribed drugs. Our aim in the
26 present study was to update this 'starter formulary' to ensure its continued
27 relevance for prescriber training.

28 **Methods**

29 We analysed large contemporary primary and secondary care datasets to identify
30 the most frequently prescribed medicinal products. Items were classified into
31 natural groups, broadly following their British National Formulary classification. The
32 resulting drug groups were included in the core list if they comprised $\geq 0.1\%$
33 prescriptions in both settings or $\geq 0.2-0.3\%$ prescriptions in one setting. Drugs from
34 emergency guidelines that did not qualify by prescribing frequency completed the
35 list.

36 **Results**

37 Over 1 billion primary care items and approximately 1.8 million secondary care
38 prescriptions were analysed. The updated list comprises 81 drug groups commonly
39 prescribed in both settings; 6 from primary care; 7 from secondary care; and 6 from
40 emergency guidelines. 88% of the formulary was unchanged. Notable changes
41 include entry of newer anti-epileptics and dipeptidyl peptidase-4 inhibitors and exit
42 of phenytoin and thiazolidinediones.

43 **Conclusions**

44 The relative stability of the core drug list over 9 years and the current update ensure
45 that learning based on this list remains relevant to practice. Trainee prescribers may
46 be encouraged to use this 'starter formulary' to develop a sound basis of prescribing
47 knowledge and skills that they can subsequently apply more widely.

48

49 **Keywords**

50 Medical education, pharmacoepidemiology, general medicine

51

52 **Structured summary**

53 **1: What is already known about this subject:**

- 54 • Prescribing is a complex skill, acquisition of which can be facilitated by use of
55 a personal formulary
- 56 • In 2006-9 we developed a 'starter formulary' of the 100 drugs most
57 commonly prescribed in the UK
- 58 • This drug list remained stable over 2 years and was consistent with practice
59 of new prescribers

60 **2: What this study adds:**

- 61 • We used primary and secondary prescribing data from 2015 to update the
62 'starter formulary'
- 63 • Most drugs in the list remain the same, with 12 differences attributable to
64 changes in practice, disease prevalence and methodology
- 65 • The list is intended not to stifle trainees' inquisitiveness, but to provide an
66 evidence-based starting point from which they can build their prescribing
67 knowledge and skills

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72 **Introduction**

73 In *Outcomes for Graduates*, the General Medical Council emphasises the safe,
74 effective and economical prescription of drugs as a core skill for all new UK medical
75 graduates [1]. The importance of prescribing skills is further emphasised by the UK
76 Prescribing Safety Assessment, which all new doctors must pass as a requirement of
77 the Foundation Programme [2,3]. Prescribing is a complex, multi-step process that
78 includes defining the clinical problem and therapeutic objectives; identifying a
79 suitable treatment; starting the treatment; giving appropriate information; and
80 monitoring treatment success [4]. The challenge faced by trainee prescribers in
81 acquiring this skill is compounded by the large number of drugs available. For
82 example, in the UK, 1,603 drugs and 18,408 preparations are licensed for
83 prescription [personal communication, British National Formulary (BNF) editorial
84 team, October 2017].

85 To facilitate development and maintenance of prescribing competence, the World
86 Health Organisation (WHO) recommends that prescribers develop a list of 'P' drugs –
87 a personal formulary of drugs that they prescribe regularly and can become familiar
88 with [4]. This is difficult for undergraduate medical students who are not yet
89 prescribing and who may see diverse practice as they rotate through healthcare
90 settings and specialties. De Vries and colleagues found that provision of any
91 formulary, whether learner or teacher-led, helped students to improve their
92 prescribing skills [5]. In 2011, we therefore developed a 'starter formulary' of the
93 100 drugs most commonly prescribed in the UK from analysis of primary and
94 secondary care prescribing data [6]. This helped students to focus their initial

95 learning on drugs they would actually prescribe in practice and supported educators
96 in developing learning resources and assessments [7].

97 Our original list was developed from analysis of primary and secondary care
98 prescribing data from 2006-9. Over the last 5-10 years, there have been significant
99 therapeutic advances, including the advent of direct oral anticoagulants and
100 dipeptidyl peptidase 4 inhibitors. The aim of this study was to update the starter
101 formulary by identifying the drugs most commonly prescribed in primary and
102 secondary care in 2015, thereby supporting relevant modern-day learning for new
103 prescribers.

104

105 **Methods**

106 **Overview**

107 NHS Prescription Cost Analysis (PCA) data was used to identify all items dispensed in
108 the community in England in 2015 [8]. Electronic prescription records were used to
109 identify all items prescribed in the University Hospital Birmingham NHS Foundation
110 Trust in 2015. Medicinal products identified in each healthcare setting were formed
111 into natural groups, guided by their classification in the British National Formulary
112 (BNF) [9]. The most commonly prescribed drug groups in both or either setting were
113 combined with drugs identified from emergency guidelines to generate the final core
114 drug list.

115 **Study approvals**

116 This study did not require ethical approval as it was based wholly on aggregate data,
117 with no linkage to patient-level data

118 **Data collection**

119 Primary care

120 NHS PCA data for England 2015 was obtained. This is based on information obtained
121 from prescriptions sent to the Prescription Pricing Division of the NHS Business
122 Services Authority. All prescriptions dispensed in the community are included, the
123 majority of which are written by general practitioners. Analysis was based on the
124 frequency with which each medicinal product was dispensed.

125 Secondary care

126 A list of all items prescribed in University Hospital Birmingham NHS Foundation Trust
127 in 2015 was obtained from their electronic prescribing system. Analysis was based
128 on the frequency of medicinal product prescription.

129 Emergency drugs

130 A review of hospital guidelines generated a list of all emergency drugs used in
131 hospital emergency settings [10].

132 **Compiling the core list**

133 In accordance with a prospectively defined analysis plan, the PCA dataset was
134 cleaned to remove items that fell outside the definition of a medicinal product [11]
135 (e.g. sunscreens, camouflages, appliances and nutritional supplements). We also
136 removed intravenous fluid preparations and vaccines because, although they fall
137 within the definition of medicinal products, we judged that they represent
138 educationally distinct groups. Finally, we planned to apply clinical–educational
139 judgment to remove drugs used in highly specialised practice that fell outside the
140 scope of a core drug list for trainee prescribers.

141 The PCA data was used to develop natural drug groups. Medicinal products were
142 first classified by BNF sub-paragraph. The products within each sub-paragraph were
143 then classified by chemical name to identify and separate individual drug classes.
144 Where several chemical entities fell naturally into a drug class, this was used as a
145 group for analysis purposes. Conversely, where a chemical entity fell into a class of

146 its own, it was named and analysed as such. For example, the BNF sub-paragraph
147 '*Lipid-regulating drugs*' was separated into statins, fibrates and ezetimibe. In a few
148 cases, e.g. '*Nicotine replacement and related drugs*', the BNF sub-paragraph was
149 retained as the basis for the drug group. Where necessary, clinical judgment was
150 applied to ensure groupings were natural and clinically applicable. The drug groups
151 developed from the PCA data were then used to sort drugs in the secondary care
152 data.

153 Compound products were not included as distinct items if their constituent
154 ingredients were already captured in the top 100 list. Where different members of
155 drug classes were used for more than one indication the drug class was included only
156 once (e.g. H₁ receptor antagonists for nausea, allergy) and the frequencies summed.

157 Prescribing frequency

158 For the PCA data, the number of items dispensed for all medicinal products within
159 each drug group was summed and expressed as a percentage of the total number of
160 items dispensed.

161 For the secondary care data, the number of prescriptions written for all medicinal
162 products within each drug group was summed and expressed as a percentage of the
163 total number of prescriptions.

164 Generating the top 100 drug list

165 Prior to the analysis it was decided that the list would contain 100 drug groups as a
166 number that was educationally attractive, sufficient to cover most prescribing by
167 foundation doctors [6] and limited enough to be considered core.

168 Drug groups qualified for the top 100 list if they comprised $\geq 0.1\%$ prescriptions in
169 both primary and secondary care; $\geq 0.2\%$ prescriptions in primary care but $< 0.1\%$
170 prescriptions in secondary care; or $\geq 0.3\%$ prescriptions in secondary care but $< 0.1\%$
171 prescriptions in primary care. These definitions were chosen to optimise inclusion of
172 drugs that were widely prescribed across healthcare systems and to reduce the
173 inclusion of more specialist drugs e.g. those with high use by a single specialist team
174 in secondary care but not commonly prescribed by non-specialist doctors. - As the
175 number of drug groups meeting these criteria exceeded 100, clinical and educational
176 judgement was used to review the less commonly prescribed drugs from these lists,
177 selecting those considered to be prescribed by generalists over those requiring more
178 specialist expertise. In addition drugs from emergency guidelines that did not qualify
179 by prescribing frequency but were considered to be clinically important were
180 identified and room was made for them on the list by removing more specialist
181 drugs.

182 Comparison of methodology between 2006-9 and 2015

183 Prescription cost analysis data was used to analyse items dispensed in the
184 community in both 2006-9 and 2015 using broadly similar approaches. Minor
185 changes in 2015 included a pre-planned decision to exclude intravenous fluids and
186 vaccines from the analysis and to exclude combination products (e.g. analgesia,
187 inhalers) from the final list where the constituent drugs were already included.

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188 The main difference between studies was in the methods used to obtain the
189 secondary care data. In 2006-9, a by-hand audit of paper drug charts of inpatients in
190 two London hospitals was used to identify 7705 individual prescriptions. In 2015, a
191 list of all (2.129 million) items prescribed that year in a single large teaching hospital
192 was obtained from their electronic prescribing system. The 2015 secondary care data
193 gives a much more comprehensive picture of secondary care prescribing, albeit from
194 a single hospital with some distinct tertiary practice.

195

196 **Results**

197 The PCA 2015 dataset comprised 1.037 billion dispensed items, of which 24.775
198 million items were ineligible for inclusion (figure 1). The Birmingham hospital data
199 set comprised 2.129 million prescriptions, of which 360,000 prescriptions were
200 ineligible for inclusion. The primary and secondary care analysis datasets therefore
201 comprised 1.013 billion items dispensed and 1.779 million prescriptions respectively.

202 **Core drug list**

203 Eighty one drug groups that made up $\geq 0.1\%$ items dispensed in primary care and
204 prescriptions in secondary care comprised the majority of the list (table 1). Two
205 drugs that met these criteria (nicorandil, 0.1% hospital prescriptions, 0.3% primary
206 care items; hydroxychloroquine 0.1% hospital prescriptions, 0.1% primary care
207 items) were considered more for specialist than generalist use and therefore not
208 included in the final list.

209 All 5 drug groups that made up $\geq 0.2\%$ items dispensed in primary care alone were
210 included in the core drug list (table 2). In addition, '*drugs for breast cancer*',
211 comprising 0.19% items dispensed) was included.

212 Eleven drug groups made up $\geq 0.3\%$ prescriptions in secondary care alone and 7 of
213 these were included in the final list (table 3). The 4 drug groups excluded from the
214 ~~not included in the~~ core final list because they were considered to require more
215 specialist than generalist expertise were *N*-Methyl-D-aspartate receptor antagonists
216 (e.g. ketamine), 1.9% prescriptions; immunosuppressants (e.g. tacrolimus,
217 ciclosporin), 1.3% prescriptions; drugs for human immunodeficiency virus (HIV)

218 infection (e.g. ritonavir), 1.1% prescriptions; and carbapenems (e.g. meropenem),
219 0.5% prescriptions.

220 Six drugs from emergency guidelines that did not qualify by prescribing frequency
221 were considered clinically important and completed the list (table 4).

222 **Changes in core drug list from 2006-2009 to 2015**

223 There were 12 changes to the core list in 2015 from 2006-9 (table 5). Some of the
224 drugs dropping out of the core drug list did so due to changes in qualification rules
225 set in the prospectively defined analysis plan. Compound products were not included
226 as distinct items if their constituent ingredients were already captured in the top 100
227 list (compound beta 2 agonist/corticosteroid inhalers; opioids, compound
228 preparations). Where different members of drug classes were used for more than
229 one indication the drug class was included only once (anti-histamine anti-emetics
230 and H₁ receptor antagonists were separate in the old list and combined in the new
231 list). Vaccines and antisera were excluded because, although they fall within the
232 definition of medicinal products, we judged that they were educationally distinct.
233 Electrolytes were split and analysed as their constituents (e.g. oral potassium, oral
234 magnesium, intravenous electrolytes), which didn't individually make the list based
235 on prescribing frequency.

236
237 Other drugs dropping out of the core list did so due to a fall in prescribing frequency
238 relative to new entrants. These were anti-emetics, phenothiazines; dipyridamole;
239 diuretics, potassium-sparing diuretics with other diuretics; laxatives, bulk forming,
240 phenytoin and thiazolidinediones. Nicorandil was borderline for inclusion on the

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241 basis of prescribing frequency, but was excluded from the final list to make room for
242 emergency medicines, as it was judged more specialist than generalist compared to
243 other borderline drugs.

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244 All new entrants to the list qualified through an increase in relative prescribing
245 frequency. For some drugs this represents a genuine increase in use e.g. direct oral
246 anticoagulants, DPP-4 inhibitors, levetiracetam. For others, drug use may have
247 remained constant but increased relative to some of those leaving the list (e.g.
248 thiazolidinediones, phenytoin) where use has decreased.

249 ~~Drug groups that dropped out of the list included those used with decreasing~~
250 ~~frequency (e.g. thiazolidinediones, phenytoin, potassium-sparing diuretics) or~~
251 ~~excluded by new list criteria (e.g. compound products for which the constituent~~
252 ~~drugs were already part of the list, vaccines, combining entries of drugs used in more~~
253 ~~than one therapeutic area). Drugs entering the list were those where frequency of~~
254 ~~prescription or dispensing had increased relative to other drugs used in primary and~~
255 ~~secondary care settings.~~

256 **Comparison of core drugs list to the World Health Organisation list of essential**
257 **medicines**

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258 The World Health Organisation (WHO) compiles and updates a core list of minimum
259 medicines required for a basic health-care system and a complementary list of
260 essential medicines for priority diseases where some specialist facilities, care or
261 training are needed for their use [12]. Together these lists contain around 438
262 individual drugs. To determine the applicability of the core drug list to trainee
263 prescribers working in healthcare systems outside England we compared our list to

264 | the World Health Organisation list of essential medicines [12]. Seventy eight percent
265 | of our core drugs were on the WHO essential list and 4% were on the
266 | complementary list. Drugs not on the WHO list or on the complementary list only are
267 | shown in table 6.
268

269 **Discussion**

270 We have identified the drug groups most commonly prescribed in England in primary
271 and secondary care settings in 2015. We have used this analysis to develop a ‘top
272 100 drugs’ list to provide a starting point for trainee prescribers being introduced to
273 pharmacology for the first time. This new list updates our previous analysis of 2006-9
274 prescribing data [6]. Reassuringly, only 12% of drugs in the list have changed,
275 indicating that learning based on this resource could have long term relevance for
276 prescribing in practice.

277 Some of the changes in the updated list reflect changes in qualification rules, such as
278 removal of separate entries for compound preparations and drug groups used in
279 more than one therapeutic area. Other changes however are likely to reflect genuine
280 changes in prescribing guidelines and practice. For example, in 2010 the European
281 Committee on Medicinal Products for Human Use recommended suspension of the
282 marketing authorisation of rosiglitazone, a thiazolidinedione, due to emerging
283 evidence of cardiovascular risk [13]. Another thiazolidinedione, troglitazone, had
284 previously been withdrawn from the British market in 1997 due to hepatotoxicity
285 [14]. Although pioglitazone, remains available for prescription and is still included in
286 English guidelines produced by the National Institute for Health and Care Excellence
287 (NICE) for the management of type 2 diabetes [15], concerns about the safety of this
288 drug class and adoption of alternatives, including the dipeptidyl peptidase-4
289 inhibitors (entering the list in 2015), likely account for the fall in thiazolidinedione
290 prescribing. Another example is change in antiepileptic drug prescribing. Phenytoin,
291 which was included in the 2006-9 list, was put on a ‘potential signals of serious risks’

292 list by the United States Food and Drug Administration (FDA) in 2008 and is no
293 longer recommended as either first line or adjunctive therapy for the prevention of
294 any seizure type by NICE [16]. Carbamazepine and sodium valproate (in both old and
295 new lists), as well as lamotrigine and levetiracetam (entering the list in 2015), are
296 preferred. Phenytoin remains on the World Health Organisation List of essential
297 medicines [12] and is still listed in NICE guidelines as adjunctive treatment to
298 benzodiazepines for status epilepticus. There is therefore a case to include it in the
299 top 100 list as an emergency drug. As trials seek to replace its use even for status
300 epilepticus with safer alternatives [17], we have made the judgement to leave it out
301 of our list. Other educators and learners may wish to include it in theirs.

302 ~~We can only speculate on the reasons for changes in prescribing frequency. They~~
303 ~~may reflect shifts in prescribing practice, such as less frequent use of phenytoin in~~
304 ~~favour of better tolerated antiepileptic agents such as levetiracetam and~~
305 ~~lamotrigine.~~ Other changes in the list may be due to increasing disease prevalence or
306 diagnosis. For example increasing rates of diagnosis of dementia and prescription of
307 anti-dementia drugs [12,18] could be responsible for the entry of
308 acetylcholinesterase inhibitors to the list. Differences in data collection between the
309 two analyses may also have had an effect. In 2006-9, secondary care prescribing data
310 was collected by hand and so only included approximately 7,500 prescriptions,
311 whereas in 2015 use of electronic prescribing data allowed inclusion of nearly 1.8
312 million secondary care prescriptions.

313 Our list was developed using prescribing and dispensing data from England. To
314 determine its relevance to an international audience we reviewed it against the

315 WHO essential and complementary medicines lists [12]. Over three quarters of drugs
316 on our list are considered essential for a basic healthcare system and are therefore
317 likely to be used worldwide. We considered the WHO list in its entirety (438 drugs)
318 to be overwhelming for a beginner prescriber and feel that our core list has an
319 important place in helping novice prescribers to direct most of their initial attention
320 to the most commonly prescribed drugs.

321 A list of drugs to learn about perhaps seems an old fashioned concept in an era
322 where healthcare education seeks to be patient-centred, integrated and problem-
323 based and curricula are moving to define and assess higher level competencies.
324 Learning to prescribe is a complex process, well suited to a spiral curriculum where
325 learners acquire understanding of the principles of clinical pharmacology, knowledge
326 of drugs and therapeutics, and skills in prescribing in parallel, through multiple
327 'visits' to the topic of increasing complexity [19]. A core drug list gives trainee
328 prescribers a tool to focus their acquisition of knowledge around drugs that they will
329 use in early clinical practice. It allows them to build their learning from knowledge of
330 the pharmacology of individual drugs, through understanding how these drugs are
331 used in the management of common diseases to prescribing them in simulated, then
332 real, clinical scenarios. The principles and skills developed can then be applied to
333 unfamiliar drugs encountered in practice. A core drug list can also help educators to
334 design useful learning resources [7] and assessments that are relevant to practice.
335 For example learners could be assessed on their knowledge of drugs on the core list,
336 but on their skills in information gathering to support safe prescribing of an
337 unfamiliar drug.

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339 **Limitations**

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340 Our analysis has several limitations. The primary care data reflects English
341 prescribing practice only, although we consider that it should be broadly
342 representative of UK practice. With an appropriate overlay of local clinical-
343 educational judgement, it may have broader generalisability. Our finding that over
344 three quarters of drugs on the core list were also on the WHO essential medicines
345 list supports this. Secondary care data was obtained from a single hospital, and may
346 therefore be affected by local prescribing patterns, population characteristics, and
347 specialist services. However, it is reassuring that the large majority of items on the
348 list were prescribed frequently in both primary and secondary care, suggesting that
349 most do not reflect specialist or centre-specific practice. Moreover, we applied
350 clinical-educational judgment to exclude drugs considered to be mainly for specialist
351 use and beyond the scope of a new prescriber.

352 The method of analysis and definition of drug groupings also had potential to
353 influence the results. The complex process of screening BNF sub-paragraphs, classes
354 and individual drugs requires some subjective judgement. However, this was
355 informed by considerable experience of both clinical practice and prescriber training,
356 aiming to produce educationally useful, clinically relevant groups. These are fully
357 described so that educators using the list may also apply their own judgment.

358 **Conclusion**

359 | Personal formularies are ~~a~~-valuable tools to improve prescribing skills, but can be
360 | difficult to develop without help for the trainee prescriber. We have produced a core
361 | drug list of the most commonly prescribed drug groups in ~~the~~-England to assist in
362 | this process. We consider that it should be generalisable to UK practice and – if
363 | supported by appropriate clinical–educational judgement – more widely. Updating
364 | this formulary has resulted in 12 changes from 2006-9, keeping the list up to date
365 | with contemporary prescribing practice. This core drug list is not intended to restrict
366 | the scope of teaching or to stifle students’ inquisitiveness. Rather, it should be
367 | considered as a ‘starter formulary’ to help novice prescribers to direct most of their
368 | early attention to the most commonly prescribed drugs.
369 |

370 **Acknowledgements**

371

372 The analysis presented in this paper used the “NHS Business Services Authority
373 Prescription cost analysis data 2015, NHSBSA Copyright 2018” This information is
374 licenced under the terms of the Open Government Licence.

375

376 **Conflict of interest statement**

377 Professor Baker described the top 100 most commonly prescribed drugs in 2006-9 in
378 the British Journal of Clinical Pharmacology [Reference Baker E, Roberts AP, Wilde K,
379 Walton H, Suri S, Rull G, Webb A. Development of a core drug list towards improving
380 prescribing education and reducing errors in the UK. Br J Clin Pharmacol.
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382

383 Subsequently, Drs Hitchings, Lonsdale and Burrage and Professor Baker published a
384 text book with Elsevier entitled 'The top 100 drugs, clinical pharmacology and
385 practical prescribing'. This was based on the 2006-9 top 100 drugs list and these
386 authors were paid royalties by the publisher. The same authors have already
387 produced a second edition (2E) of the Top 100 drugs book, based on the updated
388 2015 analysis reported in this paper. Top 100 2E will be published in 2018 and these
389 same authors will receive further royalties for this work.

390 Drs Audi and Pontefract and Professor Coleman have no conflicts of interest relating
391 to this paper

392

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452

453 **Table 1. Drugs, classes and BNF groupings comprising ≥0.1% of both primary and**
454 **hospital prescriptions**

455

Overall rank	Drug, class or BNF grouping	Most commonly prescribed example(s)	Hosp. rank	PCA rank	Hosp. %	PCA %
1	Proton pump inhibitors	omeprazole, lansoprazole	3	2	3.0%	5.5%
2	Statins	simvastatin, atorvastatin, pravastatin	9	1	2.3%	6.5%
3	Paracetamol		1	11	6.2%	2.3%
4	Beta-blockers	bisoprolol, atenolol, propranolol	17	5	1.8%	3.6%
5	Calcium and vitamin D		11	12	2.1%	2.1%
6	Calcium-channel blockers	amlodipine, felodipine, diltiazem, nifedipine, lercanidipine	21	4	1.8%	3.7%
7	H ₁ receptor antagonists	cyclizine, cetirizine, loratadine, fexofenadine, chlorphenamine	6	19	2.7%	1.6%
8	Aspirin		18	8	1.8%	2.8%
9	Opioids: weak/moderate	tramadol, codeine, dihydrocodeine	5	21	2.8%	1.4%
10	Opioids: strong	morphine	2	27	5.2%	1.2%
11	Beta ₂ agonists	salbutamol, salmeterol	22	10	1.5%	2.3%
12	Angiotensin-converting enzyme inhibitors	ramipril, lisinopril, perindopril	30	3	1.1%	4.3%
13	Diuretics, loop	furosemide, bumetanide	12	22	2.1%	1.4%
14	Vitamin K antagonists	warfarin	6	28	2.5%	1.1%
15	Vitamins	folic acid, thiamine hydrochloride, vitamin B group	16	20	1.8%	1.5%
16	Non-steroidal anti-inflammatory drugs	naproxen, ibuprofen	28	13	1.1%	2.1%
17	Penicillins, broad spectrum	amoxicillin, co-amoxiclav	19	24	1.8%	1.4%
18	Laxatives - osmotic	macrogol, lactulose	13	33	2.1%	0.9%
19	Anti-depressants, selective serotonin re-uptake inhibitors	citalopram, sertraline, fluoxetine	42	6	0.7%	3.2%
20	Corticosteroids, systemic	prednisolone	10	38	2.1%	0.8%
21	Laxatives, stimulant	senna, docusate sodium	7	41	2.5%	0.7%
22	Corticosteroids, inhaled	beclometasone, fluticasone, budesonide	39	14	0.8%	2.0%
23	Thyroid hormones	levothyroxine	50	7	0.6%	2.9%
24	Benzodiazepines	diazepam, temazepam, lorazepam	26	32	1.2%	1.0%

25	Alpha-adrenoceptor blocking drugs	doxazosin, tamsulosin	34	25	0.8%	1.3%
26	Metformin Biguanides	metformin	45	15	0.7%	1.9%
27	Insulin		24	43	1.3%	0.7%
28	Angiotensin-II receptor antagonists	losartan, candesartan, irbesartan	54	16	0.5%	1.8%
29	Corticosteroids, topical	hydrocortisone	63	9	0.4%	2.4%
30	Gabapentin and pregabalin		43	29	0.7%	1.0%
31	Anti-depressants, tricyclic and related drugs	amitriptyline	56	19	0.4%	1.6%
32	Anti-platelet drugs	clopidogrel	41	34	0.7%	0.9%
33	Anti-fungal drugs	clotrimazole, ketonazole	31	45	1.0%	0.6%
34	Histamine (H ₂)-receptor antagonists	ranitidine	25	51	1.3%	0.5%
35	Diuretics, thiazide and thiazide-like	Bendroflumethiazide, indapamide	65	18	0.3%	1.7%
36	Emollients		58	31	0.4%	1.0%
37	Nitrates	isosorbide mononitrate, glyceryl trinitrate	48	42	0.6%	0.7%
38	Trimethoprim		35	55	0.8%	0.4%
39	Iron	ferrous fumarate, ferrous sulfate	51	40	0.6%	0.7%
40	Bisphosphonates	alendronic acid	57	36	0.4%	0.8%
41	Penicillins, penicillinase-resistant	flucloxacillin	46	54	0.6%	0.4%
42	Sulfonylureas	gliclazide	67	35	0.3%	0.8%
43	Macrolides	clarithromycin	53	49	0.5%	0.5%
44	Gout and hyperuricaemia	allopurinol	60	48	0.4%	0.5%
45	Alginates and antacids		59	50	0.4%	0.5%
46	Anti-depressant drugs, other	venlafaxine, mirtazapine	80	30	0.2%	1.0%
47	Z drugs	zopiclone	66	46	0.3%	0.6%
48	Ocular lubricants (artificial tears)	hypromellose	75	39	0.3%	0.8%
49	Anti-emetics, dopamine (D ₂)-receptor antagonists	metoclopramide, domperidone	27	88	1.2%	0.2%
50	Anti-muscarinics, cardiovascular and gastrointestinal uses	atropine, hyoscine butylbromide	52	64	0.1%	0.5%
51	Anti-psychotics: 2nd	quetiapine, olanzapine, risperidone	81	37	0.2%	0.8%

	generation					
52	Anti-muscarinics, bronchodilators	tiotropium, ipratropium bromide	73	47	0.3%	0.6%
53	Digoxin Cardiac glycosides digoxin		61	61	0.4%	0.3%
54	Methotrexate		44	79	0.7%	0.2%
55	Anti-muscarinics, genitourinary uses	solifenacin, tolterodine, oxybutynin	92	44	0.2%	0.6%
56	Anti-proliferative immunosuppressants	azathioprine	32	104	1.0%	0.1%
57	Tetracyclines	doxycycline	90	52	0.2%	0.4%
58	Aldosterone antagonists	spironolactone	76	66	0.3%	0.3%
59	Metronidazole		64	81	0.4%	0.2%
60	Dipeptidyl peptidase-4 inhibitors	sitagliptin, linagliptin	95	57	0.2%	0.4%
61	Anti-motility drugs	loperamide	68	84	0.3%	0.2%
62	Quinine sulfate		97	56	0.2%	0.4%
63	Dopaminergic drugs used in parkinsonism	co-careldopa (carbidopa / levodopa)	99	58	0.2%	0.4%
64	Lamotrigine		101	59	0.2%	0.4%
65	Direct oral anticoagulants	rivaroxaban, apixaban, dabigatran	94	69	0.2%	0.3%
66	Anti-psychotics: 1st generation	haloperidol	69	94	0.3%	0.1%
67	Mucolytics	carbocisteine	81	78	0.2%	0.2%
68	Levetiracetam		74	90	0.3%	0.2%
69	Prostaglandin analogues	latanoprost	112	53	0.1%	0.4%
70	Penicillin	benzylpenicillin, phenoxymethylpenicillin	93	75	0.2%	0.2%
71	Valproate		107	63	0.1%	0.3%
72	5 α -reductase inhibitors	finasteride	109	62	0.1%	0.3%
73	Chloramphenicol		115	65	0.1%	0.3%
74	Aminosalicylates	mesalazine	103	77	0.1%	0.2%
75	Nitrofurantoin		113	73	0.1%	0.2%
76	Carbamazepine		117	72	0.1%	0.2%
77	Antivirals	aciclovir	84	105	0.2%	0.1%
78	Cephalosporins	ceftriaxone, cefalexin	85	106	0.2%	0.1%
79	Local anaesthetics	lidocaine	116	92	0.1%	0.1%
80	Amiodarone		100	108	0.2%	0.1%
81	Drugs used in substance	nicotine, methadone	111	100	0.1%	0.1%

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457 Abbreviations: BNF, British national formulary; PCA, prescription cost analysis; Hosp.,
458 hospital.

459 For each drug the prescribing frequency in terms of rank and percentage of
460 prescriptions are shown for both primary (PCA) and secondary (hosp.) care. The
461 average rank in both healthcare settings was calculated and determined the overall
462 rank.

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464

465 **Table 2. Drugs, classes and BNF groupings comprising ≥0.2% prescriptions in**
 466 **primary care but <0.1% prescriptions in secondary care**

467

	Drug, class or BNF grouping	Most commonly prescribed example(s)	PCA rank	PCA (%)
1	Oestrogens and progestogens	combined ethinylestradiol, desogestrel, estradiol	27	1.2%
2	Phosphodiesterase (type 5) inhibitors	sildenafil	61	0.3%
3	Acetylcholinesterase inhibitors	donepezil	72	0.2%
4	Serotonin (5HT ₁)-receptor agonists	sumatriptan	75	0.2%
5	Leukotriene receptor antagonists	montelukast	79	0.2%
6	<u>Drugs for b</u> Breast cancer	tamoxifen	83	0.19%

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Abbreviations: BNF, British national formulary; PCA, prescription cost analysis

471 **Table 3. Drugs, classes and BNF groupings comprising $\geq 0.3\%$ prescriptions in**
 472 **secondary care but $< 0.1\%$ prescriptions in primary care**

473

	Drug, class or BNF grouping	Most commonly prescribed example(s)	Hosp. rank	Hosp %
1	Heparins	enoxaparin, heparin	4	2.9%
2	Serotonin (5HT ₃)-receptor antagonists	ondansetron	8	2.4%
3	Oxygen		21	1.7%
4	Quinolones	ciprofloxacin, moxifloxacin	37	0.8%
5	Penicillins, anti-pseudomonal	piperacillin sodium/tazobactam sodium	38	0.8%
6	Vancomycin		48	0.6%
7	Aminoglycosides	gentamicin	72	0.3%

474

475 Abbreviations: BNF, British national formulary; Hosp., hospital.

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478 **Table 4. Drugs identified from emergency guidelines not qualifying for the core list**
479 **by prescribing frequency but considered to be core learning for new prescribers**

480

1	Activated charcoal
2	Adrenaline (epinephrine)
3	Adenosine
4	Acetylcysteine
5	Fibrinolytics e.g. alteplase
6	Naloxone

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482 Drugs from emergency guidelines are in alphabetical order

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485 **Table 5. Changes in core drug list between 2006-9 and 2015**

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Drugs dropping out of the core list	New entrants to the list
Anti-emetics, phenothiazines ²	Acetylcholinesterase inhibitors
Compound (beta-2 agonist corticosteroid) inhalers ¹	Antiproliferative immunosuppressants
Dipyridamole ²	Antivirals
Potassium, oral <u>Electrolytes e.g. potassium, magnesium</u> ¹	Sex hormone antagonists for breast cancer
Laxatives, bulk forming ²	Chloramphenicol
Nicorandil ³	Dipeptidyl peptidase-4 inhibitors
Opioids, compound preparations ¹	Lamotrigine
Phenytoin ²	Leukotriene receptor antagonists
Diuretics, potassium-sparing <u>Potassium sparing diuretics with other diuretics (e.g. co-amilofruse)</u> ²	Levetiracetam
Thiazolidinediones ²	Direct oral anticoagulants
Vaccines and antisera ¹	Serotonin (5HT ₁)-receptor agonists
Anti-histamine anti-emetics combined with H ₁ receptor antagonists in the new list ¹	Mucolytics

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1. Drugs dropping out of the list due to changes in qualification rules

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2. Drugs dropping out of the list due to reduction in relative prescribing or dispensing frequency

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3. Drug with more specialist use making way for drugs for more generalist use

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Table 6. Drugs in the English top 100 starter formulary that are not in the World

Health Organisation's essential medicines list

- 1 Alpha-adrenoceptor blocking drugs
- 2 Gabapentin and pregabalin
- 3 Emollients
- 4 Alginates and antacids
- 5 Anti-depressant drugs, other (venlafaxine, mirtazapine)
- 6 Z drugs
- 7 Ocular lubricants (artificial tears)
- 8 Anti-muscarinics, genitourinary uses
- 9 Dipeptidyl peptidase-4 inhibitors
- 10 Direct oral anticoagulants
- 11 Mucolytics e.g. carbocisteine
- 12 Levetiracetam
- 13 5 α -reductase inhibitors
- 14 Phosphodiesterase (type 5) inhibitors
- 15 Acetylcholinesterase inhibitors
- 16 Serotonin (5HT₁)-receptor agonists
- 17 Leukotriene receptor antagonists

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18 Adenosine

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On the complementary list

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19 Anti-proliferative immunosuppressants e.g. azathioprine

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20 Amiodarone

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21 Drugs for breast cancer e.g. tamoxifen

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22 Fibrinolytics e.g. streptokinase

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498 **Figure legends**

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500 **Figure 1**

501 Flow diagram showing acquisition, exclusion and processing of prescribing data from

502 primary and secondary care and emergency guidelines to produce the core drug list

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504 **Word count**

505 Abstract 246 words

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