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Estimated cost-based prices for injectable medicines in the WHO Essential Medicines List

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ABSTRACT

objectives

Challenges remain in ensuring universal access to affordable essential medicines. We previously estimated the expected generic prices based on cost of production for medicines in solid oral formulations (i.e. capsules or tablets) on the World Health Organization Model List of Essential Medicines (EML). The objectives of this analysis were to estimate cost-based prices for injectable medicines on the EML and to compare these to lowest current prices in the UK, South Africa, and India.

design

Data on the cost of active pharmaceutical ingredients (API) exported from India were extracted from an online database of customs declarations (www.infodriveindia.com). A formula was designed to use API price data to estimate a cost-based price, by adding the costs of converting API to a finished pharmaceutical product, including the cost of formulation in vials or ampoules, transportation, taxes, and an average profit margin.

results

For injectable formulations on the WHO EML, medicines had prices above the estimated cost-based price in 75% of comparisons in the UK (median ratio 2.45), and 65% in South Africa (median ratio 1.47), while 83% of medicines in India were below estimated cost-based price (median ratio 0.29). 19% of injectable medicines in the UK, 12% in South Africa, and 5% in India had prices more than 10 times the estimated cost-based price. Medicines that appeared in the top 20 by ratio of lowest current price to estimated cost-based price for more than one country included numerous oncology medicines – irinotecan, leuprorelin, ifosfamide, daunorubicin, filgrastim, and mesna – as well as linezolid and ciclosporin.

conclusions

Estimating manufacturing costs can identify cases in which profit margins for medicines may be set significantly higher than average.

setting/participants/interventions/outcome measures/trial registration

Not applicable.

Strengths and limitations of this study

- The cost assumptions used to estimate cost-based prices were conservative
- The key input of API price was based on average prices of actual, completed sales of API
- Apart from the individual API price data, the costing formula was adjusted only for formulation as vial or ampoule, but not for other characteristics such as volume
- We did not estimate demand volumes and did not adjust price estimates based on demand volume

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INTRODUCTION

There are persistent challenges in ensuring access to affordable essential medicines in low-and middle-income countries (LMICs).[1] The World Health Organization's Model List of Essential Medicines (EML) comprises medicines that meet the priority health needs of global populations and should be available at all times, at affordable prices.[2] A previous analysis estimated the cost of production for solid oral formulations in the EML, finding sizeable differences between cost of manufacture and current prices in the UK, South Africa, and India.[3]

A number of differences between solid oral formulations and injectable formulations could be expected to affect manufacturing costs, such significantly higher requirements for manufacturing sites to maintain product sterility for intravenous and intramuscular formulations, cost of containers like ampoules or metered-dose inhaler canisters, and different costs of excipients. Other factors may influence market dynamics for individual products – for example, the majority of injectable products are likely, in general, to be used in healthcare institutions and for more severe illness than most other formulations.

While many cases of difficulties in accessing treatment are associated with patent-protected medicines, in some cases, generic medicines may also be priced at very high levels, such as in the recent cases involving manufacturers Pfizer, Flynn, and Aspen in the UK. In these cases, manufacturers dramatically increased prices of generic medicines, arguably taking advantage of a dominant position they held in the respective markets.[4,5]

We aimed to develop an algorithm for estimating the cost of manufacture for injectable medicines on the WHO EML, to use this algorithm to estimate prices that would be expected assuming an average profit margin, and to compare these estimated cost-based prices to current prices in the UK, South Africa, and India.

METHODS

In our earlier analysis of solid oral formulations (SOF), we developed a costing formula that accounted for capital expenses, the cost of excipients, and the cost of formulation into tablets.[3] We have also previously developed a costing formula for biosimilars of insulin formulated in vials.[6]

Here, we developed a similar formula for injectable medicines, and submitted data on the cost of active pharmaceutical ingredients (API) to the formula to generate cost-based estimated generic prices. We then compared these estimated prices to current market prices in three countries – the UK, South Africa, and India.

medicines included in the analysis

We analysed medicines listed in the 2015 WHO EML as injectable formulations.[7] We use the term ‘item’ to describe an individual medicine-formulation-dosage listing. Besides SOF, we further excluded certain categories of medicines, due both to limitations in reliably identifying API data and/or were we considered that the market would be a special case (e.g. blood products). These categories included blood products, diagnostic agents, antivenom, vaccines, simple water-based solutions (e.g. 0.9% sodium chloride), and vitamins and minerals. A full list of included and excluded medicines/formulations is available in the appendix.

cost of API

Data on API exported from India were retrieved from an online database of customs declarations (www.infodriveindia.com), a source that we have used in numerous previous analyses of manufacturing costs.[3,6,8–12] API shipments in the date range 1 July 2014 to 1 July 2016 were included, extending the range 2 years into the past if <100 records were returned, and repeating this until at least 100 records were available, or until the timeframe spanned 6 years.

API data were manually cleaned to remove entries that did not represent genuine API (e.g. shipments of FPP; see appendix for details), after which a linear regression model, weighted by size in kilograms of individual shipments, was applied to estimate an average API price per kilogram at the data cut-off date (November 2016)(see appendix for an example).

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3 For some medicines, dosage is expressed as the dose of the active molecule, while the API is sold as
4 a salt form (e.g. one vial of '80mg methylprednisolone' contains 106mg of methylprednisolone
5 sodium succinate). We adjusted the cost of API needed per unit accordingly.
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10 Statistical analyses of API export data were done in Stata/IC V.14.0 for Mac.
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13 **cost of manufacture of injectables**

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17 We have previously estimated cost-based prices that could be achieved in a competitive market for
18 various SOF medicines,[3,8–12] as well as for insulins.[6] We divide the manufacturing cost
19 estimation into four parts: the cost of API, the cost of converting the API into an finished
20 pharmaceutical product (FPP), and operating expenditures including a profit margin. The cost
21 estimation formula is given in Figure 1 and explained further below.
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27 The cost of API per dose was calculated as described earlier.
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30 The cost of converting API into an FPP includes the cost of constructing and operating manufacture
31 sites, raw materials such as glass vials, and process wastage (i.e. the proportion of the API that is
32 wasted in the process of formulating it into an FPP). In general, we aimed to use conservative (high)
33 assumptions in estimating the cost of production.
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38 Injectable items in the EML divide broadly into those for which the designated formulation is an
39 ampoule, and those for which the designated formulation is a vial. In some cases, the EML does not
40 indicate whether formulation is as a vial or ampoule – for these items we assumed one or the other
41 based on the more prevalent form found across the UK, South Africa, and India.
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46 To design conservative assumptions for ampoule/vial formulation costs, we reviewed the lowest-
47 priced products formulated as vials or ampoules in the UK eMIT database (see next section). These
48 lowest prices are around US\$0.20 for ampoules and US\$0.50 for vials (appendix). We used these
49 values as assumed formulation costs. These are of course conservative assumptions, as for those
50 products API costs and operating margins (and transportation costs, taxes, etc.) would have to be
51 zero for the price to represent formulation alone. This is reflected in a recent analysis of the cost of
52 manufacture of vaccines, which estimated the cost of sterile formulation as an ampoule to be
53 around \$0.12/unit, and as a vial to be around US\$0.35/unit, with these values including raw
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3 materials (i.e. the vial or ampoule itself), labour, facility and equipment costs, and overheads.[13] It
4 is worth noting that Indian government standards on pharmaceutical manufacturing costs,
5 previously used to inform price ceilings, set allowable costs at a substantially lower level: ampoule
6 costs at \$0.03-0.13 and vial costs at \$0.05-0.21 (ranges depending on size and type)(appendix).
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11 We assumed that 10% more API is needed than the stated dosage, to account for loss of API in the
12 vial/ampoule filling process and vial/ampoule overfill.
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16 We assumed a net profit margin of 10% (the average operating margin in the US was 12% in
17 2013).[14]
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21 Though these cost components are highly variable between countries, an analysis by IMS Health
22 found that costs associated with import (transport, tariffs, other charges) were around 5% in most of
23 the countries surveyed (e.g. Brazil, India, Russia), and that taxes represented around 10% of the
24 final price.[15] We therefore added a 10% margin for transportation costs, and 10% margin to
25 account for taxation.
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30 31 **prices in the UK, South Africa, and India**

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35 Prices were collected in December 2016.
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39 For the UK, prices were collected from the British National Formulary (BNF) and the electronic
40 market information tool (eMit). The BNF lists 'indicative prices' and is a reference used by clinicians
41 and pharmacists. eMit provides actual government-purchase prices. The lowest price available
42 across the two sources was used. For South Africa, prices were collected from a database of prices in
43 the public healthcare system as well as a database of prices in the private market, both published by
44 the Department of Health. The lowest price available across the two sources was used. For India,
45 prices reported in public tenders of the state of Tamil Nadu were used. Where prices were not
46 available in this source, we used the price reported in an online database of Indian Maximum Retail
47 Prices. Details on price sources are available in the appendix.
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55 For many medicines in the EML, multiple dosages are listed, and may be interchangeable by using a
56 larger number of smaller-dose items in the place of a larger item, or vice-versa. Individual countries
57 may procure larger some volumes of one dosage, but not the other, potentially leading to one
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3 dosage having a far higher price than would be expected, due to lower demand volume. To avoid
4 misleading findings as a result of this, for each formulation of each medicine, comparisons between
5 countries and between market prices and cost-based price estimates (for injectables) or API cost (for
6 other formulations) were made for the dosage that gave the lowest difference. As an example, for
7 an injection that is listed in 500mg and 1000mg forms, the UK-South Africa price ratio was recorded
8 as the lower between the two dosage forms. Within the context of our analysis this is a conservative
9 approach (yielding smaller differences in comparisons).
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RESULTS

Of 414 unique medicines (including combinations) on the 2015 EML, 149 fit the inclusion criteria of this analysis. API data were available for 98 of these 149 medicines (66%).

estimated cost-based prices

Estimated cost-based prices ranged from \$0.26 (enoxaparin 20mg) to \$494 (rituximab 500mg).

The comparison of lowest current prices in the UK, South Africa, and India to estimated cost-based prices for injectable items is shown in Table 1 and Figure 2. The majority of injectable items had prices significantly above the estimated cost-based prices in the UK and South Africa, however, in India, 83% of injectable items had prices below the estimated cost-based price.

The 20 items with the highest ratios of lowest current price to estimated cost-based price are shown for the UK in Table 2, for South Africa in Table 3, and for India in Table 4.

Therapeutic categories with notably higher ratios of lowest current price to estimated cost-based price included cardiovascular medicines, medicines for mental and behavioural disorders, and medicines affecting the blood (appendix).

International price comparisons

International comparisons of lowest current prices for injectable essential medicines are shown in Figure 3. Prices were higher in the UK than in South Africa in 57% of comparisons, with a median ratio of 1.26; higher in the UK than in India in 90% of comparisons, with a median ratio of 6.75; and higher in South Africa than in India in 86% of comparisons, with a median ratio of 4.13 (Figure 3).

DISCUSSION

For injectable formulations on the WHO EML, 75% of medicines had prices above the estimated cost-based price in the UK, and 65% has prices above the estimated cost-based price in South Africa, while 83% of medicines in India were below estimated cost-based price. 19% of injectable medicines in the UK, 12% in South Africa, and 5% in India had prices more than 10 times the estimated cost-based price (Table 1, Figure 2).

A few medicines were notable for appearing in the top-20 lists by ratio of current price to estimated cost-based price in more than one country (Tables 2–4): numerous oncology medicines – irinotecan, leuprorelin, ifosfamide, daunorubicin, filgrastim, and mesna – as well as the linezolid, an antibiotic, and ciclosporin, an immunosuppressant.

A wide range of market factors may contribute to the greater than average difference in manufacture costs and price. The ‘top 20’ injectable medicines are all mostly used in the in-patient hospital setting, are used in specialist treatments, are second/third-line treatments, and/or are used for short durations. These characteristics would all tend to reduce demand volumes, reduce economies of scale (both in manufacture and distribution), and reduce the buyer’s negotiating power, and may thus explain the high prices relative to manufacture costs. The great majority of medicines compared in this analysis are no longer under patent protection in the UK, South Africa, or India.[16]

Given the range of medicines included, it is difficult to make generalised comments. If cost of manufacture analysis were employed by governments to evaluate prices, large differences between current prices and estimated cost-based prices could trigger closer examination on a case-by-case basis. For example, linezolid is recently off-patent, and is used as a ‘last-resort’ antibiotic,[17] limiting demand volume. Enoxaparin and insulin, which appear in the ‘top 20’ list for India (Table 4), are biologics, meaning different regulations and higher regulatory expenses may apply. In such cases, large profit margins may be more acceptable. In other cases, such as ibuprofen (5mg in 1mL injection) and ampicillin (1000mg powder for injection) in the UK may reflect insufficient competition, inefficient procurement, or a less commonly used dosage form (Table 2). Some of these ‘top 20’ medicines may represent a substantial burden on healthcare expenditures – for example, irinotecan represented expenditures of £22 million (about US\$29 million) by the UK public healthcare system in 2016/2017.[18]

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7 Current lowest prices in India were on average lower than our estimated cost-based prices (lowest
8 current prices in India were median 29% of the estimated cost-based price; Table 1 and Figure 2).
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10 This may reflect conservative assumptions made for the cost of ampoules and vials; a substantial
11 number of items cost less than our assumed raw material cost for the ampoule/vial (primary
12 packaging) alone, which we based on prices in high-income countries (see Figure A2 in the
13 Appendix). It may also reflect the general conservative (overestimating) effect of using data on
14 exported API; API that is manufactured in-house or procured domestically may have lower prices.
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16 The use of an average API price (rather than, for example, lowest observed or first-quartile) means,
17 in most cases, that a number of API sales occurred at lower price points. Lastly, Indian prices were
18 collected from two databases – one representing the private market and one representing Tamil
19 Nadu state tenders (the lower price of the two was recorded). State tender prices are likely lower
20 than private market prices, but the majority of health expenditures in India are out-of-pocket, and of
21 these the majority are on medicines.[19]
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30 In our earlier analysis of solid oral form medicines in the EML, we found that 214 of 277 comparable
31 prices in the UK, 142 of 212 comparable prices in South Africa and 118 of 298 comparable prices in
32 India were above the estimated cost-based price. Median ratios for lowest current price to
33 estimated cost-base price were 2.7x in the UK, 1.4x in South Africa, and 0.6x in India.[3] These ratios
34 are notably similar to the comparisons in this analysis between lowest current prices and estimated
35 cost-based prices for injectables (2.5x in the UK, 1.5x in South Africa, 0.3x in India; Table 1).
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42 Analysis of the cost of production of medicines can be used in government price negotiations, price
43 control mechanisms, or in competition law contexts. In India, until 2013, a formula based on the cost
44 of manufacture was used to set ceiling prices on key medicines.[20,21] A similar approach is or has
45 been used in Bangladesh, Pakistan, and China.[21] In South African tenders, manufacturers are
46 required to submit breakdowns of their price by various cost components including API cost and
47 profit margin.[22] The WHO Guideline on Pharmaceutical Pricing Policies notes that the use of cost-
48 plus formulae may be challenging to implement due to challenges on obtaining accurate data on
49 material prices on manufacturing costs, and due to the potential for manipulation of data by
50 manufacturers to exaggerate costs and justify higher prices.[21] Indeed, in this analysis, the Indian
51 government requirement for the publication of customs data on the value of exported API has been
52 revoked since we collected data, meaning that at present the authors are not aware of an
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3 alternative, affordable source of data for API costs.[23] Nevertheless, cost of manufacture analysis
4 should be explored further as a component of pricing policies.
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8 Pricing policies linked to manufacturer costs would also need to be use alongside policies to prevent
9 shortages and stock-outs.[24] Indeed, some of the therapeutic groups identified in this analysis as in
10 many cases high differences between market prices and estimated cost-based prices, such as
11 chemotherapy medicines and antibiotics, may also be groups that are vulnerable to
12 shortages.[25,26]
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18 **limitations**

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21 The main limitation of our analysis is that our estimates do not account for differences of costs
22 individual manufacturing plants, different distribution costs (including tariffs) depending on the
23 country of manufacture and the importing country, and changes in conversion cost depending on
24 the volume of the unit. As argued above, this limitation would not preclude the use of a
25 methodology such as this one to identify medicines that may have high profit margins, for closer *ad*
26 *hoc* analysis.
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33 As data collection for this analysis finished shortly before the publication in April 2017 of the 2017
34 EML, we use the second most recent iteration, the 2015 EML.
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38 **conclusion**

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41 Most injectable medicines on the EML can be manufactured at very low cost. In the UK, about one in
42 five injectable essential medicines is priced at more than 10 times the estimated cost-based price. In
43 South Africa, this proportion is one in ten, and in India, one in twenty. Estimation of the cost of
44 manufacture could be used in government pharmaceutical pricing mechanisms, for example, by
45 identifying products for which profit margins may be notably above average.
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AUTHORS' CONTRIBUTIONS

All authors designed the study, interpreted the data, and critically reviewed the manuscript. MB and DG collected and analysed the data.

COMPETING INTERESTS

Dzintars Gotham reports personal fees for unrelated work from the Medicines Patent Pool, the Wellcome Trust, Treatment Action Group, and the World Health Organization. Melissa J Barber and Andrew M Hill report no conflicts of interest.

DATA SHARING STATEMENT

An appendix with details on methodology is available as a supplementary file.

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3 **TABLES AND FIGURES**
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Table 1. Comparison of estimated prices, API cost, and lowest current prices in UK, South Africa, and India.

	UK	South Africa	India
Injectables			
>10x estimated price	16 (19%)	7 (12%)	4 (5%)
0-10x estimated price	47 (56%)	32 (53%)	10 (12%)
Below estimated price	21 (25%)	21 (35%)	69 (83%)
Median ratio of current price to estimated price	2.45x	1.47x	0.29x

Note: multiple dosage levels of one formulation of one medicine (e.g. ifosfamide powder for injection in 1g and 2g forms) are counted as one instance in these overview statistics.

Table 2. Injectable essential medicines with the highest price compared to API cost or estimated cost-based price, in the UK.

Medicine	Unit	Lowest current price (USD)	Estimated cost-based price (USD)	Ratio
linezolid	300mL infusion bag (600mg)	\$578.50	\$0.61	954.2
irinotecan	5mL vial (100mg)	\$143.81	\$1.29	111.5
filgrastim	1mL vial (300mcg)	\$68.52	\$0.67	102.4
ibuprofen	1mL injection (5mg)	\$46.80	\$0.67	70.3
daunorubicin	powder for injection (50mg)	\$211.25	\$3.16	66.8
azathioprine	powder for injection (100mg)	\$39.99	\$0.73	55.0
ifosfamide	powder for injection (2g)	\$233.84	\$4.51	51.9
ifosfamide	powder for injection (1g)	\$118.72	\$2.59	45.9
ifosfamide	powder for injection (500mg)	\$59.35	\$1.63	36.5
mesna	10mL ampoule (1000mg)	\$38.23	\$1.24	30.8
atropine	1mL ampoule (1mg)	\$8.25	\$0.27	30.6
ampicillin	powder for injection (1000mg)	\$20.36	\$0.71	28.7
mesna	4mL ampoule (400mg)	\$17.43	\$0.66	26.6
phenobarbital	1mL injection (200mg)	\$7.32	\$0.29	25.2
leuprorelin	pre-filled syringe (7.5mg)	\$195.62	\$8.11	24.1
epinephrine	10mL ampoule (1mg)	\$6.97	\$0.29	23.7
valproic acid	4mL ampoule (400mg)	\$5.09	\$0.28	18.1
sulfamethoxazole + trimethoprim	10mL ampoule (800mg+160mg)	\$4.62	\$0.29	16.2
zidovudine	20mL vial (200mg)	\$11.60	\$0.74	15.7
ampicillin	powder for injection (500mg)	\$10.18	\$0.69	14.8

Table 3. Injectable essential medicines with the highest price compared to estimated cost-based price or API cost, in South Africa.

Medicine	Unit	Lowest current price (USD)	Estimated cost-based price (USD)	Ratio
filgrastim	1mL vial (300mcg)	\$32.38	\$0.67	48.4
linezolid	300mL infusion bag (600mg)	\$21.90	\$0.61	36.1
tranexamic acid	10mL ampoule (1000mg)	\$9.74	\$0.40	24.1
ifosfamide	powder for injection (1g)	\$33.02	\$2.59	12.8
ifosfamide	powder for injection (2g)	\$56.02	\$4.51	12.4
ifosfamide	powder for injection (500mg)	\$19.81	\$1.63	12.2
streptokinase	powder for injection (15.6mg)	\$257.52	\$21.56	11.9
amiodarone	ampoule (150mg/3mL)	\$3.30	\$0.30	11.2
digoxin	2mL ampoule (500mcg)	\$2.81	\$0.27	10.3
digoxin	2mL ampoule (500mcg)	\$2.81	\$0.27	10.3
fluphenazine	1mL ampoule (25mg)	\$2.64	\$0.35	7.5
oxaliplatin	powder for injection (100mg)	\$68.72	\$10.01	6.9
oxaliplatin	powder for injection (50mg)	\$34.36	\$5.34	6.4
magnesium sulfate	10mL ampoule (5g)	\$1.57	\$0.29	5.5
ciclosporin	1mL ampoule (50mg)	\$1.98	\$0.37	5.4
docetaxel	injection (20mg)	\$24.95	\$4.63	5.4
docetaxel	injection (40mg)	\$39.44	\$8.60	4.6
mesna	4mL ampoule (400mg)	\$2.77	\$0.66	4.2
daunorubicin	powder for injection (50mg)	\$11.53	\$3.16	3.6
vincristine	powder for injection (5mg)	\$16.00	\$4.57	3.5

Table 4. Injectable essential medicines with the highest price compared to estimated cost-based price or API cost, in India.

Medicine	Unit	Lowest current price (USD)	Estimated cost-based price (USD)	Ratio
irinotecan	25mL vial (500mg)	\$112.50	\$3.79	29.7
filgrastim	1mL vial (300mcg)	\$16.50	\$0.67	24.7
irinotecan	5mL vial (100mg)	\$22.50	\$1.29	17.4
leuprorelin	pre-filled syringe (7.5mg)	\$111.30	\$8.11	13.7
irinotecan	2mL vial (40mg)	\$11.25	\$0.92	12.3
bendamustine	2mL injection (180mg)	\$194.40	\$16.55	11.7
bendamustine	0.5mL injection (45mg)	\$48.60	\$4.64	10.5
leuprorelin	pre-filled syringe (22.5mg)	\$252.00	\$24.34	10.4
valproic acid (sodium valproate)	10mL ampoule (1g)	\$3.00	\$0.30	9.8
enoxaparin	0.6mL injection (60mg)	\$4.55	\$0.77	5.9
enoxaparin	0.2mL injection (20mg)	\$1.52	\$0.26	5.9
enoxaparin	1mL injection (100mg)	\$7.58	\$1.28	5.9
linezolid	300mL infusion bag (600mg)	\$3.47	\$0.61	5.7
ciclosporin	1mL ampoule (50mg)	\$1.80	\$0.37	4.9
testosterone	1mL ampoule (200mg)	\$1.41	\$0.30	4.7
valproic acid (sodium valproate)	4mL ampoule (400mg)	\$1.20	\$0.28	4.3
enoxaparin	0.4mL injection (40mg)	\$1.58	\$0.51	3.1
enoxaparin	0.8mL injection (80mg)	\$3.15	\$1.03	3.1
insulin injection (soluble)	10mL injection (34.7mg)	\$6.09	\$2.37	2.6
sodium nitroprusside	powder for injection (50mg)	\$0.68	\$0.28	2.4

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4 **Figure 1. Formula for estimating cost-based prices for injectable formulations.**
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7 **Figure 2. Estimated generic prices and current prices for injectables in UK, South Africa,**
8 **and India.**
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10 **Figure 3. Comparison of lowest current prices of injectable essential medicines between**
11 **the UK, South Africa, and India.**
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Multiply by mass of API needed for one dosage unit

If applicable, multiply by [MW/dosage in one unit] to adjust for salt forms

Multiply by 1.1 to account for 10% loss of API during formulation and overfill

Total cost of production per unit

Add \$0.20 for ampoule/\$0.50 for vial for cost of materials and formulation

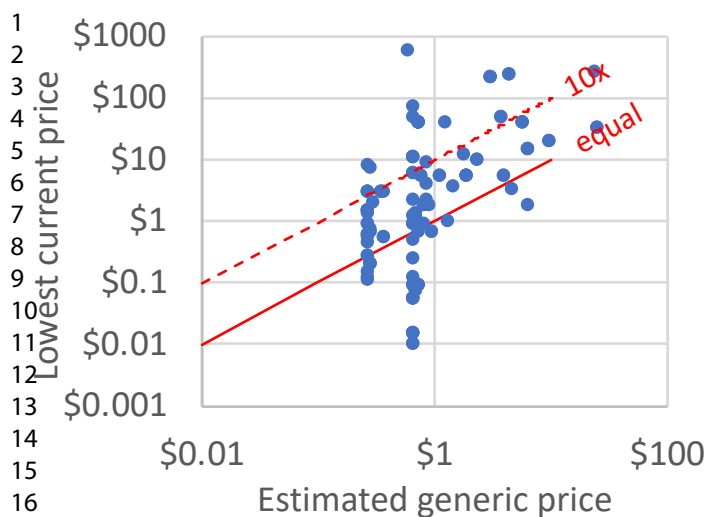
Add costs of transportation 10%

Add taxes 10%

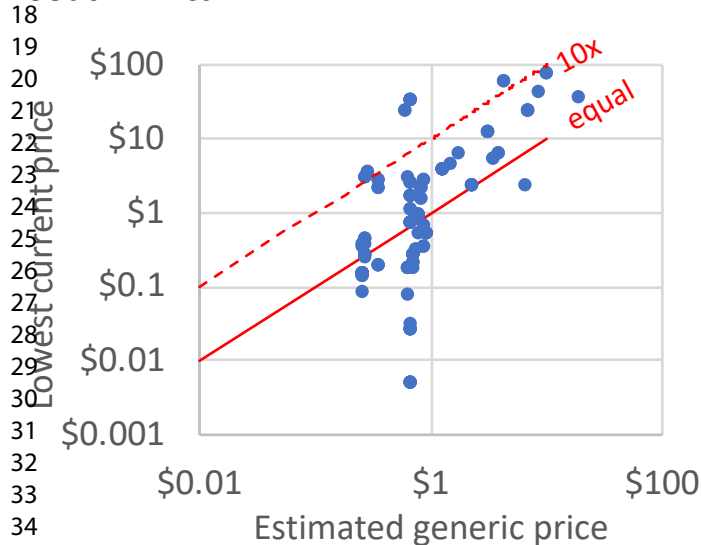
Add profit margin of 10%

Estimated cost-based price

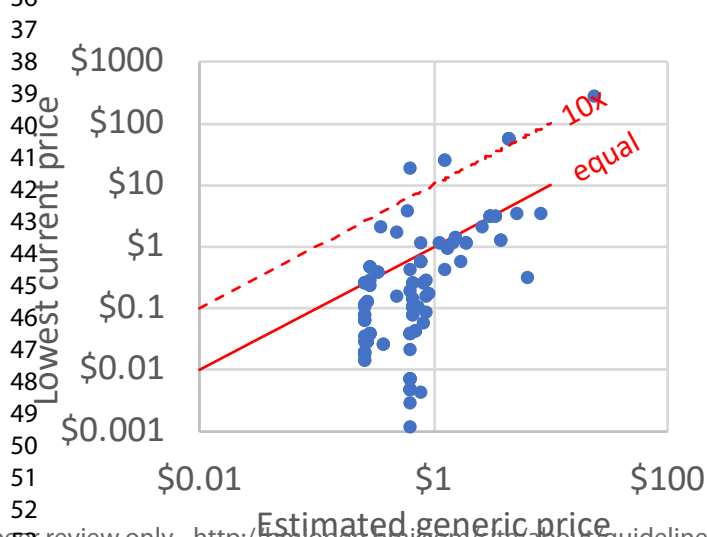
UK



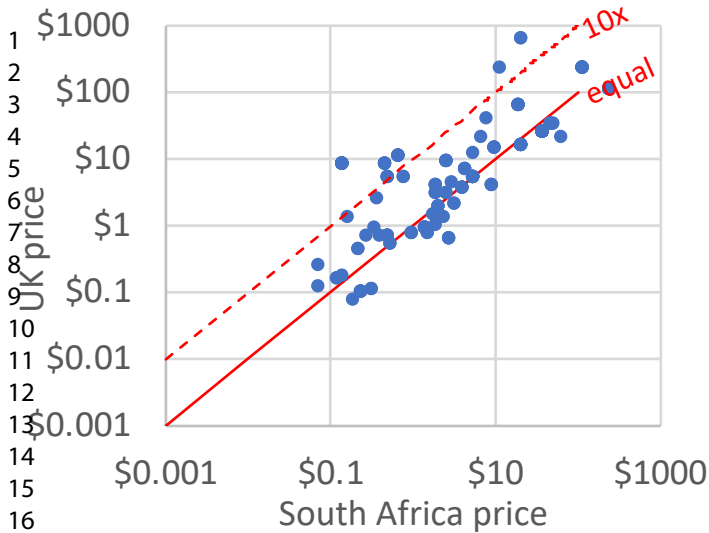
South Africa



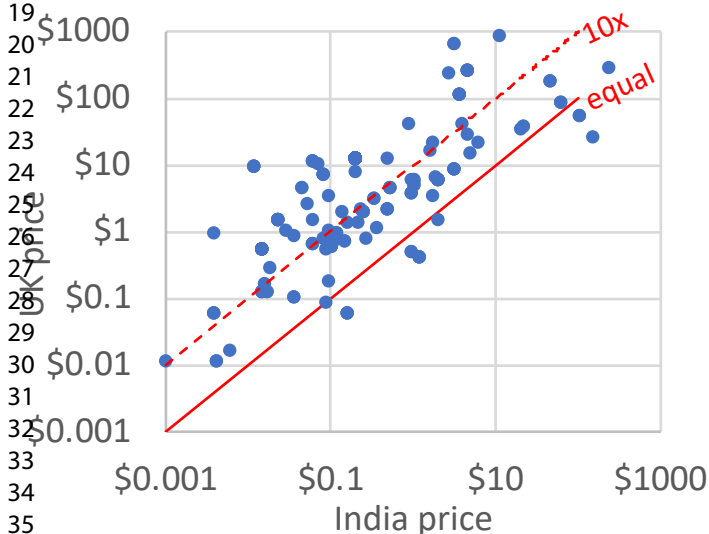
India



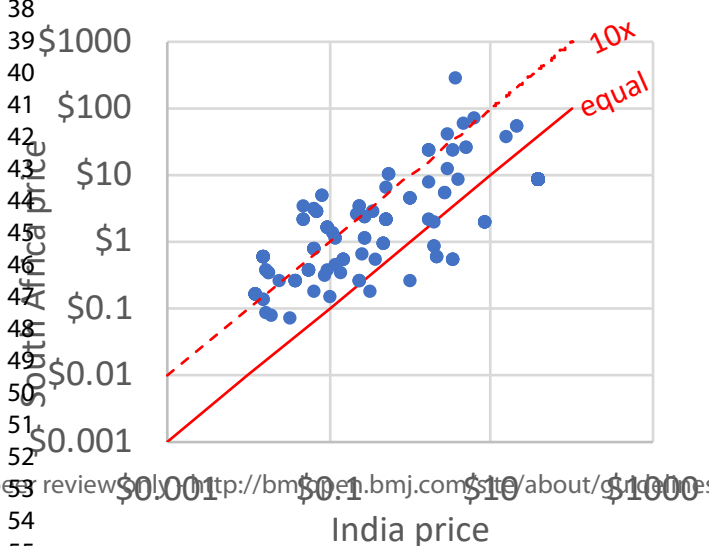
UK versus South Africa



UK versus India



South Africa versus India



Appendix

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Criteria used for cleaning export data.

Reason for censoring	Example of product description that would trigger censoring
Incorrect substance identified	"DIAMORPHINE" (in a search for "morphine")
Item is part of a mix of products	"ABACAVIR, LOPINAVIR, LAMIVUDINE API"
Quantity of shipment < 1.0 kg, with exceptions made for very low-dose medicines	Value listed in "quantity" variable greater than 1.0kg
Finished Pharmaceutical Product (FPP), for example tablets	"ABACAVIR SULFATE TABLETS 600MG"
Impurity	"ABACAVIR SULPHATE IMPURITY"
Unclear quantity of API	"ABACAVIR GRANULES 10%" (In this example, the percentage descriptor could refer to a variety of parameters, for example, moisture content. As this is not specified, the true amount of API is unknown.)
Free sample or 'no commercial value'	"ABACAVIR SULPHATE FREE SAMPLE" "ABACAVIR SULPHATE N.C.V."
For veterinary use	"IVERMECTIN VETERINARY"
Reference/working standard	"ABACAVIR WORKING STANDARD"

This table is reproduced from an earlier publication as this element of the methodology was identical:

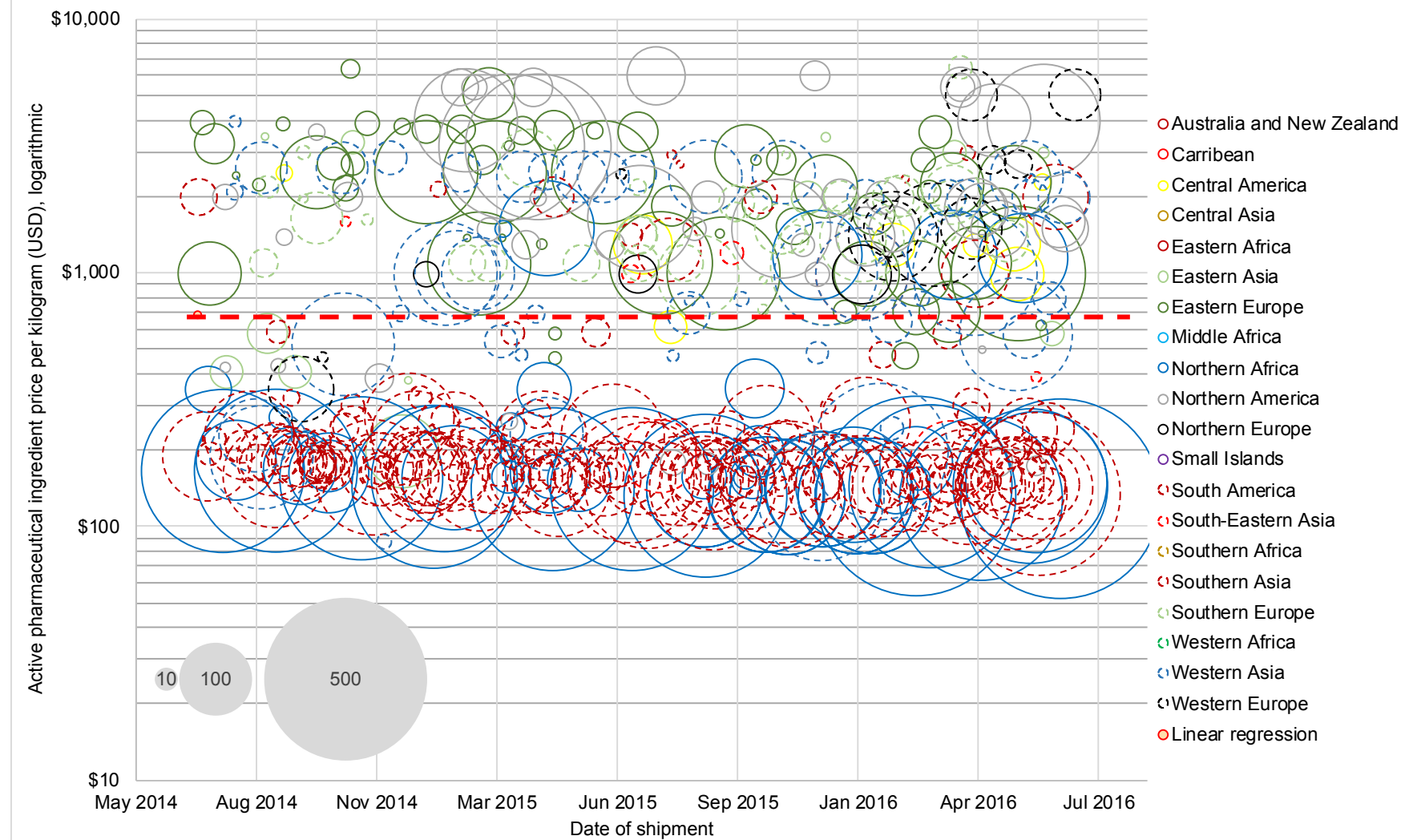
Hill A, Barber MJ, Gotham D. Estimated costs of production and potential prices for the WHO Essential Medicines List. *BMJ Global Health* 2018; e000571.

Included and excluded formulation types, by terms used in WHO Model List of Essential Medicines.

Included:
Concentrate for injection, depot injection, infusion, injectable solution, injection, injection for intravenous administration, injection for spinal anaesthesia, injection in oil, injection: ampoule or pre-filled syringe, injections, oily injection, oily solution, oily suspension for injection, parenteral formulation, powder for injection, solution for injection, solution for intramuscular injection, solution for IV infusion, vial or prefilled syringe.
Excluded:
Ampoule (for buccal administration when solution for oromucosal administration is not available), aqueous solution*, capsule, cream, cream (as mupirocin calcium), cream or lotion, cream or ointment, dental cartridge, detergent-based suspension, eye ointment, gel or rectal solution, granules, granules (slow-release; to mix with water), immediate release capsule, inhalation (aerosol), lotion, lozenge, metered dose inhaler (aerosol), nasal spray, ointment, oral liquid, oral powder, pessary, powder for oral administration, powder for oral liquid, rectal dosage form, rectal solution, respirator solution for use in nebulizers, retention enema, saturated solution, solid oral dosage form, solid oral dosage form (controlled-release tablets), solid oral form, solution, solution (eye drops), solution for oromucosal administration, suppository, tablet, tablet (chewable), tablet (crushable), tablet (dispersible, scored), tablet (dispersible), tablet (enteric-coated), tablet (heat stable), tablet (immediate release), tablet (scored), tablet (slow release), tablet (sublingual), topical, topical forms, transdermal patches, vaginal cream, vaginal tablet.

*this represents potassium permanganate for topical use in dermatology.

Figure A1. Example of API data: Price of linezolid API exported from India from July 1, 2014 to July 1, 2016.



Bubble colours correspond to the region of the destination country for individual shipments. Bubble sizes correspond to the size of individual shipments (size key shown in lower-left, in kilograms). The linear regression model is shown as a dashed red line; though it appears horizontal it has a slight upwards slope. The values estimated by the linear regression model were \$683/kg on July 1, 2014, and \$690/kg on July 1, 2016.

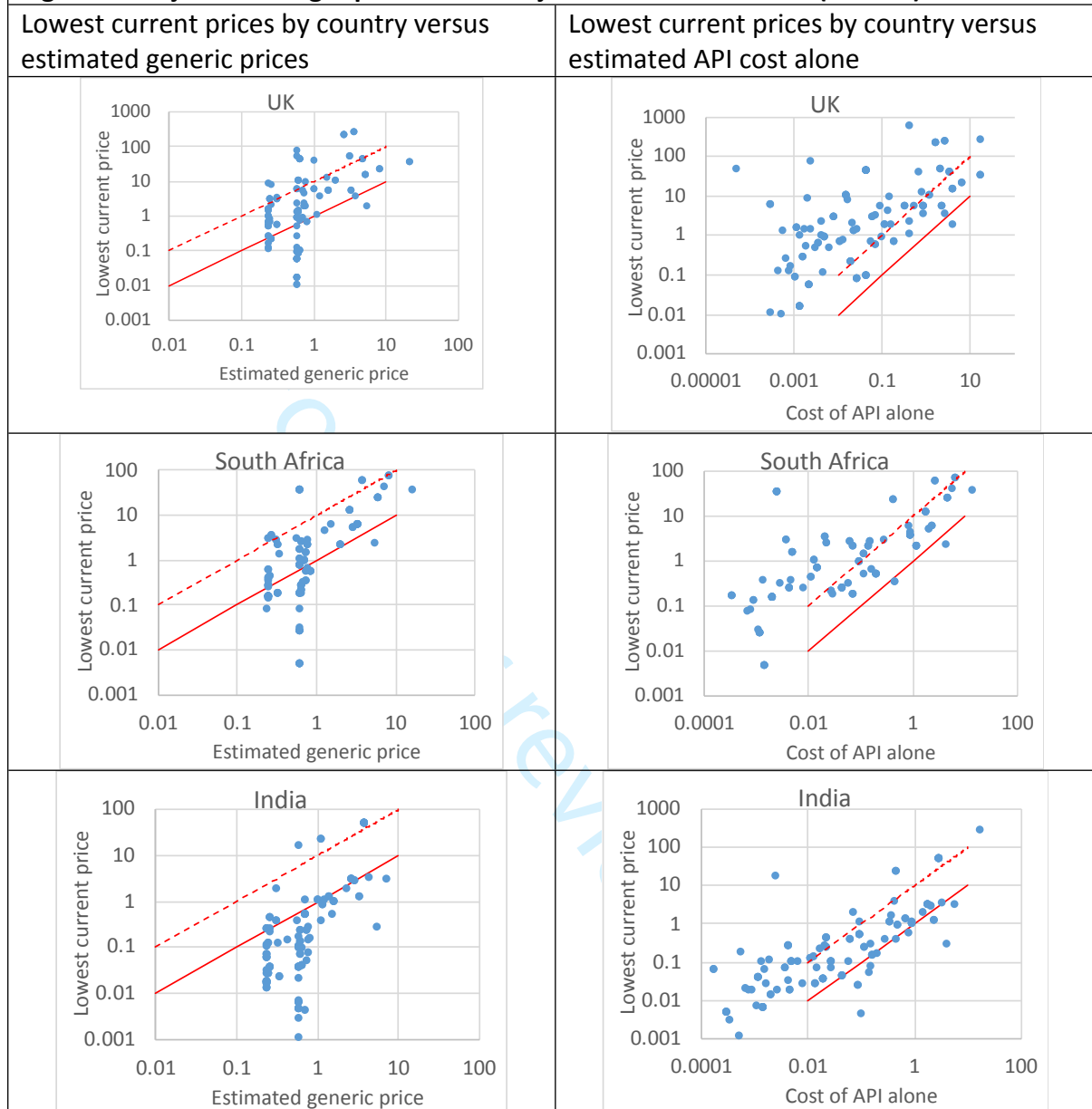
Costs prescribed in India's Drug Price Control Order (2012).

Item	Cost per unit in 2011 Indian rupees	Converted to 2016 USD
Conversion cost		
<i>Ampoules</i>		
Up to 1mL	0.4253	\$0.008
100mL	1.4327	\$0.028
<i>Sterile vials</i>		
Up to 5mL	1.22	\$0.024
100mL	3.21	\$0.063
Packing materials cost		
<i>USP type I glass vial including blister</i>		
Up to 2mL	1.48	\$0.029
100mL	6.96	\$0.136
<i>Plastic vial/bottle</i>		
Up to 2mL	0.99	\$0.019
100mL	2.96	\$0.058
<i>Ampoules</i>		
<i>White ampoule in tray</i>		
Up to 1mL	0.53	\$0.010
25mL	2.86	\$0.056
<i>Amber ampoules in blister</i>		
Up to 1mL	0.63	\$0.012
25mL	4.68	\$0.091
Packing charges		
<i>Ampoules</i>		
Up to 5mL	0.33	\$0.006
Over 15mL	0.56	\$0.011
<i>Liquid in vials</i>		
Up to 5mL	0.6	\$0.012
Over 5mL	0.69	\$0.013
<i>Sterile powder in vials</i>		
Up to 1g	0.23	\$0.004
Over 1g	0.38	\$0.007
Ampoules range		\$0.03–\$0.13
Vials range		\$0.05–\$0.21

Pharmabiz.com. NPPA notification dated Dec 27, 2012 fixing/revising the norms for conversion cost (CC), packing charges (PC), process loss (PL) and packing material. Available from: <http://pharmabiz.com/PrintArticle.aspx?aid=72988> (accessed 6 November 2018).

Rupee values were inflation-adjusted by a factor of 1.30, based on inflation data provided by the World Bank, available from <https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=IN>.

Figure A2. Injectable target prices versus injectable API cost alone (all USD).



Solid red line: Points above this line represent an instance where the lowest current price is greater than the estimated generic price/API cost.

Dashed red line: Points above this line represent an instance where the lowest current price is more than 10 times the estimated generic price/API cost.

'Floors' can be seen for estimated generic price at \$0.27 and \$0.67 – the cost-based prices estimated by our algorithm for ampoules and vials, respectively, if API costs are zero, therefore, the estimated cost-based price cannot be below these 'floors'. In all countries, it can be observed that in some cases (in India more than in South Africa more than in UK) lowest current prices go below these 'floors'.

Ratio of estimated cost-based prices to lowest current prices in the UK, South Africa, and India, by therapeutic category.

Medicine	UK	South Africa	India
Anaesthetics	0.2	0.2	0.1
Medicines for pain and palliative care	0.6	0.5	0.1
Antiallergics and medicines used in anaphylaxis	0.7	1.0	0.1
Antidotes and other substances used in poisonings	16.5	1.0	0.2
Anticonvulsants/antiepileptics	2.5	1.7	0.2
Anti-infectives	1.8	1.0	0.3
Antimigraine medicines	NA	NA	NA
Antineoplastics and immunosuppressives	2.8	2.4	0.6
Antiparkinsonism medicines	NA	NA	NA
Medicines affecting the blood	6.0	2.8	1.4
Cardiovascular medicines	4.7	10.3	0.2
Dermatological Medicines (topical)	NA	NA	NA
Diuretics	0.2	0.1	0.0
Gastrointestinal medicines	1.2	1.1	0.1
Hormones, other endocrine medicines and contraceptives	4.1	0.9	2.7
Muscle relaxants (peripherally-acting) and cholinesterase inhibitors	1.4	0.5	0.1
Ophthalmological Preparations	NA	NA	NA
Oxytocics and antioxytocics	3.4	1.4	0.4
Medicines for mental and behavioural disorders	5.2	7.5	0.1
Medicines acting on the respiratory tract	0.7	NA	0.1
Ear, nose and throat medicines (children)	NA	NA	NA
Specific medicines for neonatal care	39.4	0.9	0.1
Medicines for diseases of joints	NA	NA	NA

Full results table: Lowest current prices in the UK, South Africa, and India, and estimated cost-based generic prices.

Medicine	Unit	UK price (USD)	UK price source	South Africa price (USD)	India price (USD)	India source	Cost of API per unit	Estimated cost-based product price per unit
acetylcysteine	2000mg ampoule	\$1.36	eMIT	\$1.81	\$2.10	TN		
aciclovir	powder for injection (250mg)	\$1.24	eMIT	\$2.42	\$0.24	TN	\$0.02215	\$0.69793
amikacin	powder for injection (100mg)	\$2.38	eMIT	\$0.38	\$0.06	TN		
amikacin	powder for injection (500mg)	\$11.92	eMIT	\$0.32	\$0.14	TN		
amikacin	powder for injection (1000mg)	\$23.83	eMIT	\$0.64	\$0.28	TN		
amiodarone	ampoule (150mg/3mL)	\$1.95	BNF	\$3.30	\$0.25	TN	\$0.02024	\$0.29583
amphotericin B	powder for injection (50mg)	\$5.04	BNF		\$1.07	TN	\$0.09296	\$0.80160
amphotericin B	powder for injection (50mg)	\$5.04	BNF		\$1.07	TN	\$0.09296	\$0.80160
ampicillin	powder for injection (500mg)	\$10.18	BNF	\$0.70	\$0.07	TN	\$0.01471	\$0.68703
ampicillin	powder for injection (1000mg)	\$20.36	BNF	\$1.39	\$0.13	TN	\$0.02941	\$0.70856
artemether	ampoule (80mg/1mL)				\$0.42	P	\$0.02194	\$0.29832
asparaginase	powder for injection (10,000iU)	\$796.90	BNF		\$12.15	TN		
atracurium	1mL injection (10mg)	\$0.86	BNF		\$0.00	TN	\$0.09646	\$0.80673
atropine	1mL ampoule (1mg)	\$8.25	BNF	\$0.15	\$0.01	TN	\$0.00198	\$0.26910
atropine	1mL ampoule (1mg)	\$8.25	BNF	\$0.15	\$0.01	TN	\$0.00198	\$0.26910
azathioprine	powder for injection (100mg)	\$39.99	BNF				\$0.04225	\$0.72736
bendamustine	0.5mL injection (45mg)				\$48.60	P	\$2.71305	\$4.63768
bendamustine	2mL injection (180mg)				\$194.40	P	\$10.85220	\$16.55421
benzathine benzylpenicillin	5mL vial (900mg)				\$0.17	P		
benzathine benzylpenicillin	5mL vial (1.44g)				\$0.24	P		
benzylpenicillin	powder for injection (600mg)	\$3.04	BNF		\$0.10	TN		
benzylpenicillin	powder for injection (3g)	\$15.18	BNF		\$0.51	TN		
bevacizumab	1mL injection (25mg)	\$78.86	BNF		\$66.75	TN		
bleomycin	powder for injection (15mg)	\$24.78	BNF		\$4.83	TN		
bupivacaine	1mL injection (5mg)	\$0.09	eMIT	\$0.03	\$0.01	TN	\$0.00103	\$0.66701
bupivacaine	1mL injection (2.5mg)	\$0.11	eMIT		\$0.02	P	\$0.00051	\$0.66625
bupivacaine	4mL ampoule (20mg, with glucose)			\$0.24	\$0.24	P	\$0.00411	\$0.27222
caffeine citrate	1mL injection (20mg)	\$5.70	eMIT				\$0.00030	\$0.66594
calcium folinate	10mL ampoule (30mg)	\$6.01	BNF		\$1.97	P		
calcium gluconate	10mL ampoule (1000mg)	\$0.65	eMIT	\$0.41	\$0.12	P	\$0.01106	\$0.28239
capreomycin	powder for injection (1000mg)	\$37.19	BNF	\$8.23	\$4.13	P		
carboplatin	5mL injection (50mg)	\$4.64	eMIT	\$4.39	\$1.85	TN	\$1.43635	\$2.76845
carboplatin	15mL injection (150mg)	\$9.91	eMIT	\$13.16	\$5.99	TN	\$4.30904	\$6.97436
carboplatin	60mL injection (600mg)	\$32.83	eMIT	\$52.63	\$23.94	TN	\$17.23615	\$25.90095
carboplatin	45mL injection (450mg)	\$24.78	eMIT	\$34.51	\$16.61	TN	\$12.92711	\$19.59208
cefazolin	powder for injection (1000mg)			\$0.61	\$0.27	TN	\$0.15187	\$0.88785

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4	cefotaxime	powder for injection (250mg)	\$1.31	eMIT	\$0.17	\$0.07	TN	\$0.02734	\$0.70553
5	ceftazidime	powder for injection (250mg)	\$1.77	eMIT	\$0.51	\$0.37	P	\$0.10774	\$0.82325
6	ceftazidime	powder for injection (1000mg)	\$0.99	eMIT	\$2.04	\$0.38	P	\$0.43097	\$1.29649
7	ceftriaxone	powder for injection (250mg)	\$1.43	eMIT	\$0.31	\$0.08	TN	\$0.04759	\$0.73517
8	ceftriaxone	powder for injection (1000mg)	\$0.64	eMIT	\$0.51	\$0.15	TN	\$0.19035	\$0.94419
9	chloramphenicol	powder for injection (1000mg)	\$1.81	BNF		\$0.14	P	\$0.15906	\$0.89837
10	chloramphenicol	2mL ampoule (1000mg)				\$0.14	P	\$0.15906	\$0.49907
11	chlorpromazine	2mL ampoule (50mg)	\$0.92	eMIT		\$0.03	P	\$0.00429	\$0.27249
12	chlorpromazine	2mL ampoule (50mg)	\$0.92	eMIT		\$0.03	P	\$0.00429	\$0.27249
13	ciclosporin	1mL ampoule (50mg)	\$3.02	BNF	\$1.98	\$1.80	P	\$0.06771	\$0.36533
14	ciprofloxacin	1mL solution for infusion (2mg)	\$0.01	eMIT		\$0.00	TN	\$0.00051	\$0.66624
15	cisplatin	50mL injection (50mg)	\$9.09	eMIT	\$5.09	\$2.70	P	\$1.94314	\$3.51046
16	cisplatin	100mL injection (100mg)	\$13.73	eMIT	\$10.17	\$5.40	P	\$3.88629	\$6.35542
17	clindamycin	1mL injection (150mg)	\$0.37	eMIT		\$1.28	P		
18	cloxacillin	powder for injection (500mg)			\$1.02	\$0.13	TN	\$0.01268	\$0.68407
19	cyclizine	1mL injection (50mg)	\$2.11	eMIT				\$0.00419	\$0.67163
20	cyclophosphamide	powder for injection (500mg)	\$11.53	eMIT	\$5.79	\$0.53	TN	\$0.78130	\$1.80940
21	cytarabine	powder for injection (100mg)	\$3.99	eMIT	\$2.07	\$0.05	TN	\$0.13341	\$0.86083
22	dacarbazine	powder for injection (100mg)	\$5.42	eMIT		\$1.07	TN	\$0.33923	\$1.16217
23	dactinomycin	powder for injection (500mcg)				\$6.17	P		
24	daunorubicin	powder for injection (50mg)	\$211.25	BNF	\$11.53	\$2.91	TN	\$1.70665	\$3.16421
25	deferoxamine	injection (500mg)	\$5.19	BNF	\$0.54	\$2.23	TN		
26	deferoxamine	powder for injection (500mg)	\$5.19	BNF	\$0.54	\$2.23	TN		
27	desmopressin	1mL ampoule (4mcg)	\$1.46	eMIT				\$0.00112	\$0.26784
28	dexamethasone	1mL ampoule (4mg)			\$0.24	\$0.03	TN	\$0.00790	\$0.27777
29	dexamethasone	1mL ampoule (4mg)			\$0.24	\$0.03	TN	\$0.00790	\$0.27777
30	dexamethasone	1mL ampoule (4mg)			\$0.24	\$0.03	TN	\$0.00790	\$0.27777
31	dexamethasone	1mL ampoule (4mg)			\$0.24	\$0.03	TN	\$0.00790	\$0.27777
32	dexamethasone	1mL ampoule (4mg)			\$0.24	\$0.03	TN	\$0.00790	\$0.27777
33	diazepam	1mL injection (5mg)	\$0.25	eMIT	\$0.07	\$0.02	TN	\$0.00065	\$0.66646
34	digoxin	2mL ampoule (500mcg)	\$0.60	eMIT	\$2.81	\$0.07	P	\$0.00354	\$0.27138
35	digoxin	2mL ampoule (500mcg)	\$0.60	eMIT	\$2.81	\$0.07	P	\$0.00354	\$0.27138
36	dimercaprol	2mL ampoule (100mg)				\$1.58	P		
37	docetaxel	injection (40mg)			\$39.44	\$3.04	TN	\$5.42209	\$8.60398
38	docetaxel	injection (20mg)	\$3.30	eMIT	\$24.95	\$1.52	TN	\$2.71104	\$4.63474
39	dopamine	5mL vial (200mg)	\$0.68	eMIT	\$0.30	\$0.09	TN	\$0.05528	\$0.74644
40	doxorubicin	powder for injection (10mg)	\$1.99	eMIT	\$1.95	\$0.52	TN	\$0.45249	\$1.32800
41	doxorubicin	powder for injection (50mg)	\$5.25	eMIT	\$5.82	\$1.19	TN	\$2.26247	\$3.97798
42	eflornithine	100mL injection (20g)						\$27.83990	\$41.42589
43	enoxaparin	0.8mL injection (120mg)	\$11.43	BNF				\$1.05251	\$1.54098
44	enoxaparin	1mL injection (150mg)	\$12.99	BNF				\$1.31564	\$1.92622
45	enoxaparin	0.2mL injection (20mg)	\$2.71	BNF	\$0.85	\$1.52	TN	\$0.17542	\$0.25683
46	enoxaparin	1mL injection (100mg)	\$9.40	BNF	\$3.62	\$7.58	TN	\$0.87709	\$1.28415
47	enoxaparin	0.6mL injection (60mg)	\$5.10	BNF	\$2.60	\$4.55	TN	\$0.52625	\$0.77049
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4	enoxaparin	0.4mL injection (40mg)	\$3.94	BNF	\$1.71	\$1.58	TN	\$0.35084	\$0.51366
5	enoxaparin	0.8mL injection (80mg)	\$7.17	BNF	\$3.41	\$3.15	TN	\$0.70167	\$1.02732
6	ephedrine	1mL ampoule (30mg)	\$0.52	eMIT		\$0.11	TN	\$0.00184	\$0.26889
7	epinephrine								
8	(adrenaline)	10mL ampoule (1mg)	\$6.97	eMIT				\$0.01878	\$0.29369
9	epinephrine								
10	(adrenaline)	1mL ampoule (1mg)	\$0.20	eMIT		\$0.04	TN	\$0.01878	\$0.29369
11	epinephrine								
12	(adrenaline)	1mL ampoule (1mg)	\$0.20	eMIT		\$0.04	TN	\$0.01878	\$0.29369
13	ergometrine	1ml ampoule (0.2mg)				\$0.03	P		
14	erythromycin	powder for injection (500mg)	\$11.12	eMIT					
15	etoposide	5mL ampoule (100mg)	\$3.47	eMIT	\$4.21	\$1.02	TN	\$0.84629	\$1.50525
16	filgrastim	1mL vial (300mcg)	\$68.52	BNF	\$32.38	\$16.50	P	\$0.00245	\$0.66909
17	filgrastim	1.6mL vial (480mcg)						\$0.00392	\$0.67124
18	fluconazole	1mL vial (2mg)	\$0.01	eMIT		\$0.00	TN	\$0.00028	\$0.66592
19	flucytosine	250mL infusion (2.5g)	\$39.43	BNF				\$3.44262	\$5.70584
20	fludarabine	vial (50mg)	\$30.46	eMIT	\$48.33	\$21.53	TN		
21	fluorouracil	5mL ampoule (250mg)	\$0.60	eMIT		\$0.10	P		
22	fluphenazine	1mL ampoule (25mg)	\$2.78	eMIT	\$2.64	\$0.36	P	\$0.05980	\$0.35376
23	fomepizole	1.5mL ampoule (1500mg)						\$26.92838	\$39.69204
24	furosemide	2mL ampoule (20mg)	\$0.12	eMIT	\$0.08	\$0.02	TN	\$0.00075	\$0.26730
25	furosemide	2mL ampoule (20mg)	\$0.12	eMIT	\$0.08	\$0.02	TN	\$0.00075	\$0.26730
26	gemcitabine	vial (200mg)	\$5.19	eMIT	\$5.77	\$0.99	TN	\$0.87393	\$1.94502
27	gemcitabine	vial (1000mg)	\$40.16	eMIT	\$23.23	\$4.95	TN	\$4.36964	\$7.06309
28	gentamicin	2mL vial (80mg)	\$0.78	eMIT	\$0.27	\$0.04	TN		
29	gentamicin	2mL vial (20mg)	\$1.43	eMIT		\$0.04	P		
30	glucagon	1mL injection (1mg)	\$14.98	BNF	\$22.44	\$1.72	P		
31	haloperidol	1mL ampoule (5mg)	\$1.40	eMIT		\$0.03	TN	\$0.00166	\$0.26862
32	haloperidol	1mL ampoule (5mg)	\$1.40	eMIT		\$0.03	TN	\$0.00166	\$0.26862
33	haloperidol	1mL ampoule (5mg)	\$1.40	eMIT		\$0.03	TN	\$0.00166	\$0.26862
34	heparin sodium	1mL ampoule (6.7mg)	\$0.99	eMIT	\$0.19	\$0.02	P	\$0.08533	\$0.39113
35	heparin sodium	1mL ampoule (6.7mg)	\$0.99	eMIT	\$0.19	\$0.02	P	\$0.08533	\$0.39113
36	heparin sodium	1mL ampoule (33.3mg)	\$2.09	eMIT	\$0.32	\$0.15	TN	\$0.42411	\$0.88714
37	heparin sodium	1mL ampoule (33.3mg)	\$2.09	eMIT	\$0.32	\$0.15	TN	\$0.42411	\$0.88714
38	heparin sodium	1mL ampoule (133.3mg)						\$1.69772	\$2.75183
39	hydralazine	powder for injection (20mg)	\$2.88	BNF				\$0.00777	\$0.27758
40	hydrocortisone	powder for injection (100mg)			\$0.90	\$0.50	P	\$0.09166	\$0.79970
41	hydrocortisone	powder for injection (100mg)			\$0.90	\$0.50	P	\$0.09166	\$0.79970
42	hydroxocobalamin	1mL ampoule (1mg)	\$1.15	eMIT					
43	hyoscine								
44	hydrobromide	injection (400mcg)	\$1.10	eMIT				\$0.00159	\$0.26853
45	hyoscine								
46	hydrobromide	injection (600mcg)	\$1.33	eMIT				\$0.00239	\$0.26969
47	ibuprofen	1mL injection (5mg)	\$46.80	BNF				\$0.00005	\$0.66557
48	ifosfamide	powder for injection (500mg)	\$59.35	BNF	\$19.81	\$1.22	TN	\$0.65602	\$1.62598
49	ifosfamide	powder for injection (1g)	\$118.72	BNF	\$33.02	\$2.44	TN	\$1.31204	\$2.58646
50	ifosfamide	powder for injection (2g)	\$233.84	BNF	\$56.02	\$4.89	TN	\$2.62408	\$4.50742

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3	imipenem + cilastatin	powder for injection (250mg + 250mg)			\$1.80	\$8.93	P		
4	imipenem + cilastatin	powder for injection (500mg + 500mg)	\$3.30	eMIT	\$3.59	\$12.45	P		
5	insulin injection (soluble)	10mL injection (13.9mg)				\$0.83	TN	\$0.46524	\$1.34665
6	insulin injection (soluble)	10mL injection (34.7mg)	\$9.72	BNF	\$2.10	\$6.09	P	\$1.16309	\$2.36838
7	intermediate-acting insulin	10mL injection (13.9mg)				\$0.83	TN		
8	intermediate-acting insulin	10mL injection (34.7mg)	\$9.72	BNF	\$2.10	\$4.40	P		
9	irinotecan	2mL vial (40mg)	\$5.58	eMIT		\$11.25	P	\$0.17047	\$0.91509
10	irinotecan	5mL vial (100mg)	\$143.81	BNF		\$22.50	P	\$0.42618	\$1.28947
11	irinotecan	25mL vial (500mg)	\$46.83	eMIT		\$112.50	P	\$2.13090	\$3.78536
12	kanamycin	powder for injection (1g)				\$0.45	P		
13	ketamine	10mL vial (500mg)	\$9.10	BNF	\$2.64	\$0.08	P	\$0.14269	\$0.87441
14	leuprorelin	pre-filled syringe (7.5mg)	\$195.62	BNF		\$111.30	P	\$5.54227	\$8.11444
15	leuprorelin	pre-filled syringe (22.5mg)	\$249.42	BNF		\$252.00	P	\$16.62682	\$24.34333
16	lidocaine	vial (20mg)	\$0.06	BNF	\$0.16	\$0.00	P	\$0.00032	\$0.66597
17	lidocaine	vial (10mg)	\$0.05	BNF	\$0.46	\$0.00	P	\$0.00016	\$0.66574
18	lidocaine	2mL ampoule (100mg lidocaine + glucose)				\$0.06	P	\$0.00016	\$0.26644
19	lidocaine	5mL ampoule (100mg)	\$0.26	eMIT		\$0.02	P	\$0.00162	\$0.26857
20	lidocaine + epinephrine (adrenaline)	vial (10mg + 0.005mg)	\$0.13	BNF				\$0.00026	\$0.66587
21	lidocaine + epinephrine (adrenaline)	vial (20mg + 0.005mg)	\$0.12	BNF				\$0.00042	\$0.66611
22	linezolid	300mL infusion bag (600mg)	\$578.50	BNF	\$21.90	\$3.47	TN	\$0.41407	\$0.60624
23	lorazepam	1mL ampoule (2mg)				\$0.06	TN	\$0.00147	\$0.26835
24	lorazepam	1mL ampoule (4mg)	\$0.46	BNF		\$0.23	P	\$0.00294	\$0.27050
25	magnesium sulfate	2mL ampoule (1g)	\$0.42	eMIT	\$0.31	\$0.02	TN	\$0.00267	\$0.27011
26	magnesium sulfate	10mL ampoule (5g)	\$0.73	eMIT	\$1.57	\$0.09	TN	\$0.01335	\$0.28575
27	mannitol	1mL solution (100mg)	\$0.01	BNF		\$0.00	P	\$0.00069	\$0.66651
28	mannitol	1mL solution (100mg)	\$0.01	BNF		\$0.00	P	\$0.00069	\$0.66651
29	mannitol	1mL solution (200mg)	\$0.02	BNF	\$0.01	\$0.01	P	\$0.00138	\$0.66751
30	mannitol	1mL solution (200mg)	\$0.02	BNF	\$0.00	\$0.01	P	\$0.00138	\$0.66751
31	medroxyprogesterone acetate	1mL vial (150mg)	\$7.81	BNF	\$0.49	\$3.48	P		
32	mesna	4mL ampoule (400mg)	\$17.43	BNF	\$2.77	\$0.37	TN	\$0.26636	\$0.65618
33	mesna	10mL ampoule (1000mg)	\$38.23	BNF		\$0.92	TN	\$0.66591	\$1.24116
34	methotrexate	powder for injection (50mg)	\$1.83	eMIT	\$2.22	\$0.28	TN	\$4.04570	\$6.58881
35	methylprednisolone	1mL vial (40mg)	\$1.79	eMIT	\$1.38	\$0.23	P	\$0.11323	\$0.83128
36	methylprednisolone	1mL vial (80mg)				\$0.64	P	\$0.22647	\$0.99707
37	methylprednisolone	5mL vial (200mg)						\$0.56616	\$1.49442
38	metoclopramide	2mL ampoule (10mg)	\$0.15	eMIT	\$0.13	\$0.02	TN	\$0.00086	\$0.26746
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4	metoclopramide	2mL ampoule (10mg)	\$0.15	eMIT	\$0.13	\$0.02	TN	\$0.00086	\$0.26746
5	metronidazole	100mL vial (500mg)	\$0.47	eMIT		\$0.09	TN	\$0.00616	\$0.67452
6	metronidazole	100mL vial (500mg)	\$0.47	eMIT		\$0.09	TN	\$0.00616	\$0.67452
7	midazolam	1mL injection (1mg)	\$0.11	eMIT	\$0.07	\$0.03	TN	\$0.00526	\$0.67320
8	midazolam	1mL injection (1mg)	\$0.11	eMIT	\$0.07	\$0.03	TN	\$0.00526	\$0.67320
9	midazolam	1mL injection (5mg)	\$0.08	eMIT	\$0.20	\$0.10	P	\$0.02628	\$0.70398
10	morphine	1mL ampoule (10mg)	\$0.16	eMIT	\$0.14	\$0.11	TN		
11	morphine	1mL ampoule (10mg)	\$0.16	eMIT	\$0.14	\$0.11	TN		
12	naloxone	1mL ampoule (400mcg)	\$0.43	eMIT	\$0.24	\$1.04	TN		
13	neostigmine	1mL ampoule (500mcg)			\$0.29	\$0.03	TN	\$0.01352	\$0.28599
14	neostigmine	1mL ampoule (2.5mg)	\$0.53	eMIT	\$0.17	\$0.34	P	\$0.06758	\$0.36514
15	norethisterone enantate	1mL ampoule (200mg)	\$5.27	BNF	\$0.83	\$2.08	P		
16	omeprazole	powder for injection (40mg)	\$1.23	eMIT		\$0.17	TN	\$0.00055	\$0.66630
17	ondansetron	2mL ampoule (4mg)	\$0.11	eMIT	\$0.34	\$0.02	TN	\$0.00445	\$0.27272
18	ondansetron	2mL ampoule (4mg)	\$0.11	eMIT	\$0.34	\$0.02	TN	\$0.00445	\$0.27272
19	oxaliplatin	powder for injection (50mg)	\$13.81	eMIT	\$34.36	\$3.26	TN	\$3.19285	\$5.34016
20	oxaliplatin	powder for injection (100mg)	\$20.15	eMIT	\$68.72	\$6.52	TN	\$6.38571	\$10.01481
21	oxaliplatin	10mL vial (50mg)	\$13.81	eMIT	\$34.36			\$3.19285	\$5.34016
22	oxaliplatin	20mL vial (100mg)	\$20.15	eMIT	\$68.72			\$6.38571	\$10.01481
23	oxaliplatin	40mL vial (200mg)	\$40.30	eMIT				\$12.77141	\$19.36413
24	oxytocin	1mL ampoule (25mcg)	\$0.91	eMIT	\$0.36	\$0.10	TN	\$0.00134	\$0.26816
25	paclitaxel	powder for injection (1mg)	\$0.09	eMIT	\$0.25	\$0.04	TN	\$0.04273	\$0.72807
26	pegylated interferon alfa (2a or 2b)	injection (180mcg)	\$161.72	BNF		\$48.75	TN		
27	pegylated interferon alfa (2a or 2b)	injection (80mcg)	\$138.24	BNF		\$41.09	TN		
28	pegylated interferon alfa (2a or 2b)	injection (100mcg)	\$172.80	BNF		\$51.36	TN		
29	pentamidine	powder for injection (200mg)	\$27.54	BNF					
30	phenobarbital	1mL injection (200mg)	\$7.32	eMIT		\$0.21	P	\$0.01656	\$0.29045
31	phenytoin	5mL vial (250mg)	\$0.85	eMIT	\$1.54	\$0.10	TN	\$0.00475	\$0.67246
32	phytomenadione	5mL ampoule (50mg)	\$2.46	BNF		\$0.38	P		
33	procaine benzylpenicillin	powder for injection (3g)				\$0.51	P		
34	propofol	1mL injection (20mg)	\$0.05	eMIT		\$0.18	P	\$0.00226	\$0.66880
35	propofol	1mL injection (10mg)	\$0.03	eMIT	\$0.02	\$0.04	TN	\$0.00113	\$0.66715
36	protamine sulfate	5mL ampoule (50mg)	\$6.44	BNF	\$4.69	\$0.09	P		
37	protamine sulfate	5mL ampoule (50mg)	\$6.44	BNF	\$4.69	\$0.09	P		
38	quinine	2mL ampoule (600mg)			\$1.27	\$0.12	P	\$0.07719	\$0.37922
39	ranitidine	2mL ampoule (50mg)	\$0.48	eMIT	\$0.56	\$0.02	TN	\$0.00105	\$0.26774
40	ribavirin	10mL solution (800mg)						\$0.09776	\$0.80863
41	ribavirin	10mL solution (1g)						\$0.12220	\$0.84442
42	ribavirin	10mL solution (800mg)						\$0.09776	\$0.80863
43	ribavirin	10mL solution (1g)						\$0.12220	\$0.84442
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4	rituximab	50mL vial (500mg)	\$1,135.10	BNF	\$596.25			\$336.88802	\$493.90325
5	rituximab	10mL vial (100mg)	\$227.01	BNF	\$119.25			\$67.37760	\$99.31305
6	salbutamol	5mL ampoule (50mcg)						\$0.00001	\$0.26621
7	sodium calcium edetate	5mL ampoule (1000mg)						\$0.00334	\$0.27109
8	sodium nitrite	10mL ampoule (300mg)						\$0.00038	\$0.26675
9	sodium nitroprusside	powder for injection (50mg)				\$0.68	P	\$0.00784	\$0.27768
10	sodium stibogluconate	30mL vial (3g)	\$25.91	BNF					
11	sodium thiosulfate	50mL ampoule (12500mg)						\$0.02574	\$0.30388
12	spectinomycin	powder for injection (2g)				\$3.00	P		
13	streptokinase	powder for injection (15.6mg)	\$101.97	eMIT	\$257.52	\$3.83	P	\$14.27110	\$21.55982
14	streptomycin	powder for injection (1000mg)			\$0.34	\$0.06	P		
15	streptomycin	powder for injection (1000mg)			\$0.34	\$0.06	P		
16	sulfamethoxazole + trimethoprim	5mL ampoule (400mg+80mg)	\$2.31	BNF				\$0.00659	\$0.27584
17	sulfamethoxazole + trimethoprim	10mL ampoule (800mg+160mg)	\$4.62	BNF				\$0.01317	\$0.28548
18	sulfamethoxazole + trimethoprim	5mL ampoule (400mg+80mg)	\$2.31	BNF				\$0.00659	\$0.27584
19	sulfamethoxazole + trimethoprim	10mL ampoule (800mg+160mg)	\$4.62	BNF				\$0.01317	\$0.28548
20	suramin sodium	powder for injection (1g)							
21	suxamethonium	2mL ampoule (100mg)	\$0.86	eMIT		\$0.13	P	\$0.05053	\$0.34017
22	suxamethonium	0						\$0.00000	\$0.66550
23	testosterone	1mL ampoule (200mg)				\$1.41	P	\$0.02237	\$0.29896
24	tranexamic acid	10mL ampoule (1000mg)	\$3.90	BNF	\$9.74	\$0.57	P	\$0.09442	\$0.40444
25	trastuzumab	powder for injection (150mg)	\$529.62	BNF					
26	valproic acid (sodium valproate)	4mL ampoule (400mg)	\$5.09	eMIT		\$1.20	P	\$0.01051	\$0.28159
27	valproic acid (sodium valproate)	10mL ampoule (1g)				\$3.00	P	\$0.02628	\$0.30468
28	vancomycin	powder for injection (250mg)	\$0.72	eMIT	\$1.01	\$0.30	TN	\$0.22748	\$0.99855
29	vecuronium	powder for injection (10mg)	\$4.38	BNF		\$1.10	TN		
30	vecuronium	powder for injection (10mg)	\$4.38	BNF		\$1.10	TN		
31	verapamil	2mL ampoule (5mg)	\$1.41	BNF				\$0.00039	\$0.26677
32	vinblastine	powder for injection (10mg)	\$19.27	eMIT	\$7.13	\$1.80	TN	\$2.57796	\$4.43989
33	vincristine	powder for injection (1mg)	\$4.08	eMIT	\$3.20	\$0.05	TN	\$0.53274	\$1.44549
34	vincristine	powder for injection (5mg)	\$23.43	eMIT	\$16.00	\$0.25	TN	\$2.66370	\$4.56543
35	vinorelbine	1mL vial (10mg)	\$6.23	eMIT	\$7.78	\$38.63	P		
36	vinorelbine	5mL vial (50mg)	\$23.41	eMIT	\$38.65	\$160.26	P		
37	zidovudine (ZDV or AZT)	20mL vial (200mg)	\$11.60	BNF		\$0.21	P	\$0.05046	\$0.73938
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eMIT – price source was the electronic market information tool, available from <https://www.gov.uk/government/publications/drugs-and-pharmaceutical-electronic-market-information-emit>

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3 BNF – price source was the British National Formulary, available from

4 <https://bnf.nice.org.uk/>

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6 TN – price source was the database of the Tamil Nadu Medical Services Corporation,
7 available from

8 http://www.tnmsc.com/tnmsc/new/user_pages/drugtender.php?drugcat=drug2017 and

9 http://www.tnmsc.com/tnmsc/new/user_pages/drugtender.php?drugcat=sdg2017

10 P – price source was the MedGuide India database, available from

11 <http://www.medguideindia.com/>

12
13
14 Prices in South Africa were collected from the South Africa Department of Health Master
15 Procurement Catalogue. Available from

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3 **Exchange rates**
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5 Exchange rates used were 1 INR = 0.015 USD, 1 GBP = 1.3 USD, 1 ZAR = 0.075 USD.
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Estimation of cost-based prices for injectable medicines in the WHO Essential Medicines List

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ABSTRACT

objectives

Challenges remain in ensuring universal access to affordable essential medicines. We previously estimated the expected generic prices based on cost of production for medicines in solid oral formulations (i.e. capsules or tablets) on the World Health Organization Model List of Essential Medicines (EML). The objectives of this analysis were to estimate cost-based prices for injectable medicines on the EML and to compare these to lowest current prices in England, South Africa, and India.

design

Data on the cost of active pharmaceutical ingredients (API) exported from India were extracted from an online database of customs declarations (www.infodriveindia.com). A formula was designed to use API price data to estimate a cost-based price, by adding the costs of converting API to a finished pharmaceutical product, including the cost of formulation in vials or ampoules, transportation, and an average profit margin.

results

For injectable formulations on the WHO EML, medicines had prices above the estimated cost-based price in 77% of comparisons in England (median ratio 2.54), and 62% in South Africa (median ratio 1.48), while 85% of medicines in India were below estimated cost-based price (median ratio 0.30). 19% of injectable medicines in England, 9% in South Africa, and 5% in India had prices more than 10 times the estimated cost-based price. Medicines that appeared in the top 20 by ratio of lowest current price to estimated cost-based price for more than one country included numerous oncology medicines – irinotecan, leuprorelin, ifosfamide, daunorubicin, filgrastim, and mesna – as well as valproic acid and ciclosporin.

conclusions

Estimating manufacturing costs can identify cases in which profit margins for medicines may be set significantly higher than average.

Strengths and limitations of this study

- The cost assumptions used to estimate cost-based prices were conservative (strength)
- The key input of active pharmaceutical ingredient price was based on average prices of actual, completed sales of active pharmaceutical ingredient (strength)
- Apart from the individual active pharmaceutical ingredient price data, the costing formula was adjusted only for formulation as vial or ampoule, but not for other characteristics such as volume (limitation)
- We did not estimate demand volumes and did not adjust price estimates based on demand volume (limitation)

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INTRODUCTION

There are persistent challenges in ensuring access to affordable essential medicines in low-and middle-income countries (LMICs).[1] The World Health Organization's Model List of Essential Medicines (EML) comprises medicines that meet the priority health needs of global populations and should be available at all times, at affordable prices.[2] A previous analysis estimated the cost of production for solid oral formulations in the EML, finding sizeable differences between cost of manufacture and current prices in England, South Africa, and India.[3]

A number of differences between solid oral formulations and injectable formulations could be expected to affect manufacturing costs, such as significantly higher requirements for manufacturing sites to maintain product sterility for intravenous and intramuscular formulations. Other factors may influence market dynamics for individual products – for example, the majority of injectable products are likely, in general, to be used in healthcare institutions and for more severe illness than most other formulations.

While many cases of difficulties in accessing treatment are associated with patent-protected medicines, in some cases, generic medicines may also be priced at very high levels, such as in the recent cases involving manufacturers Pfizer, Flynn, and Aspen in England. In these cases, manufacturers dramatically increased prices of generic medicines, arguably taking advantage of a dominant position they held in the respective markets.[4,5]

We aimed to develop an algorithm for estimating the cost of manufacture for injectable medicines on the WHO EML, to use this algorithm to estimate prices that would be expected assuming an average profit margin, and to compare these estimated cost-based prices to current prices in England, South Africa, and India. Estimation of cost-based generic prices can contribute to procurement, among other things, by informing negotiations, tenders, price control mechanisms, and competition policy.

METHODS

In our earlier analysis of solid oral formulations (SOF), we developed a costing formula that accounted for capital expenses, the cost of excipients, and the cost of formulation into tablets.[3] We have also previously developed a costing formula for biosimilars of insulin formulated in vials.[6]

Here, we developed a similar formula for injectable medicines, and submitted data on the cost of active pharmaceutical ingredients (API) to the formula to generate cost-based estimated generic prices. We then compared these estimated prices to current market prices in three countries – England, South Africa, and India. We assume manufacturing in India both because of the fact that India is a major manufacturer of generics globally, and due to the greater availability of data on the bulk prices of active pharmaceutical ingredient (see below) in India compared to other countries.

medicines included in the analysis

We analysed medicines listed in the 2015 WHO EML as injectable formulations.[7] We use the term ‘item’ to describe an individual medicine-formulation-dosage listing. Besides SOF, we further excluded certain categories of medicines, due both to limitations in reliably identifying active pharmaceutical ingredient data and/or were we considered that the market would be a special case (e.g. blood products). These categories included blood products, diagnostic agents, antivenom, vaccines, simple water-based solutions (e.g. 0.9% sodium chloride), and vitamins and minerals, as well as infusion bag formulations and pre-filled syringe formulations. A full list of included and excluded medicines/formulations is available in the appendix.

cost of active pharmaceutical ingredient

Data on active pharmaceutical ingredient exported from India were retrieved from an online database of customs declarations (www.infodriveindia.com), a source that we have used in numerous previous analyses of manufacturing costs.[3,6,8–12] Active pharmaceutical ingredient shipments in the date range 1 July 2014 to 1 July 2016 were included, extending the range 2 years into the past if <100 records were returned, and repeating this until at least 100 records were available, or until the timeframe spanned 6 years.

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3 API data were manually cleaned to remove entries that did not represent genuine active
4 pharmaceutical ingredient (e.g. shipments of finished pharmaceutical product; see appendix for
5 details), after which a linear regression model, weighted by size in kilograms of individual shipments,
6 was applied to estimate an average active pharmaceutical ingredient price per kilogram at the data
7 cut-off date (November 2016)(see appendix for an example).
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13 For some medicines, dosage is expressed as the dose of the active molecule, while the active
14 pharmaceutical ingredient is sold as a salt form (e.g. one vial of '80mg methylprednisolone' contains
15 106mg of methylprednisolone sodium succinate). We adjusted the cost of active pharmaceutical
16 ingredient needed per unit accordingly.
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22 Statistical analyses of active pharmaceutical ingredient export data were done in Stata/IC V.14.0 for
23 Mac.
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25 **cost of manufacture of injectables**

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28 We have previously estimated cost-based prices that could be achieved in a competitive market for
29 various solid oral formulation medicines,[3,8–12] as well as for insulins.[6] We divide the
30 manufacturing cost estimation into four parts: the cost of active pharmaceutical ingredient, the cost
31 of converting the active pharmaceutical ingredient into a finished pharmaceutical product , and
32 operating expenditures including a profit margin. The cost estimation formula is given in Figure 1
33 and explained further below.
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40 The cost of active pharmaceutical ingredient per dose was calculated as described earlier.
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43 The cost of converting active pharmaceutical ingredient into an finished pharmaceutical product
44 includes the cost of constructing and operating manufacture sites, raw materials such as glass vials,
45 and process wastage (i.e. the proportion of the active pharmaceutical ingredient that is wasted in
46 the process of formulating it into an finished pharmaceutical product). In general, we aimed to use
47 conservative (high) assumptions in estimating the cost of production. In other words, in designing
48 our costing model, we erred on the side of overestimating the cost of production, in preference to
49 underestimating it. This has the effect of minimising the observed difference in price between
50 current prices and estimated cost-based generic prices, where the former is greater than the latter.
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3 Injectable items in the EML divide broadly into those for which the designated formulation is an
4 ampoule, and those for which the designated formulation is a vial. In some cases, the EML does not
5 indicate whether formulation is as a vial or ampoule – for these items we assumed one or the other
6 based on the more prevalent form found across England, South Africa, and India. Ampoules are
7 sealed glass containers, while vials generally have a removable cap. Assumptions on whether the
8 medicine is formulated as a vial or ampoule were made for 23% of items.
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15 To design conservative assumptions for ampoule/vial formulation costs, we reviewed the lowest-
16 priced products formulated as vials or ampoules in the eMIT database (see next section). These
17 lowest prices are around US\$0.20 for ampoules and US\$0.50 for vials (appendix). We used these
18 values as assumed formulation costs. These are, of course, conservative assumptions, as for those
19 products active pharmaceutical ingredient costs and operating margins (and transportation costs,
20 taxes, etc.) would have to be zero for the price to represent formulation alone. This is reflected in a
21 recent analysis of the cost of manufacture of vaccines, which estimated the cost of sterile
22 formulation as an ampoule to be around \$0.12/unit, and as a vial to be around US\$0.35/unit, with
23 these values including raw materials (i.e. the vial or ampoule itself), labour, facility and equipment
24 costs, and overheads.[13] It is worth noting that Indian government standards on pharmaceutical
25 manufacturing costs, previously used to inform price ceilings, set allowable costs at a substantially
26 lower level: ampoule costs at \$0.03-0.13 and vial costs at \$0.05-0.21 (ranges depending on size and
27 type)(appendix).
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38 We assumed that 10% more active pharmaceutical ingredient is needed than the stated dosage, to
39 account for loss of active pharmaceutical ingredient in the vial/ampoule filling process and
40 vial/ampoule overfill.
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45 We assumed a net profit margin of 10% (the average operating margin in the US was 12% in
46 2013).[14]
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50 Though these cost components are highly variable between countries, an analysis by IMS Health
51 found that costs associated with import (transport, tariffs, other charges) were around 5% in most of
52 the countries surveyed (e.g. Brazil, India, Russia)..[15] Based on this, we added a 10% margin for
53 transportation costs as a conservative assumption..
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58 **prices in England, South Africa, and India**
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5 Prices were collected in December 2016. Exchange rates used are given in the appendix.
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8 For England, prices were collected from the British National Formulary (BNF) and the electronic
9 market information tool (eMit). The BNF lists 'indicative prices' and is a reference used by clinicians
10 and pharmacists. eMit provides actual government-purchase prices. The lowest price available
11 across the two sources was used. For South Africa, prices were collected from a database of prices in
12 the public healthcare system as well as a database of prices in the private market, both published by
13 the Department of Health. The lowest price available across the two sources was used. For India,
14 prices reported in public tenders of the state of Tamil Nadu were used. Where prices were not
15 available in this source, we used the price reported in an online database of Indian Maximum Retail
16 Prices. Details on price sources are available in the appendix. For South Africa and India, the
17 medicine prices in the sources were assumed to include 15% and 5% value-added tax (VAT),
18 respectively, and price data was adjusted accordingly to be net of VAT. For England, the medicine
19 prices in the sources do not include VAT.
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30 For many medicines in the EML, multiple dosages are listed, and may be interchangeable by using a
31 larger number of smaller-dose items in the place of a larger item, or vice-versa. Individual countries
32 may procure larger some volumes of one dosage, but not the other, potentially leading to one
33 dosage having a far higher price than would be expected, due to lower demand volume. To avoid
34 misleading findings as a result of this, for each formulation of each medicine, comparisons between
35 countries and between market prices and cost-based price estimates (for injectables) or active
36 pharmaceutical ingredient cost (for other formulations) were made for the dosage that gave the
37 lowest difference. As an example, for an injection that is listed in 500mg and 1000mg forms,
38 England-South Africa price ratio was recorded as the lower between the two dosage forms. Within
39 the context of our analysis this is a conservative approach (yielding smaller differences in
40 comparisons).
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50 **patient and public involvement**

51 The conduct of this study did not involve patients or the public. This study is based on exclusively on
52 publicly available export, price, and trade data. Ethical board review was therefore not needed.
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RESULTS

Of 414 unique medicines (including combinations) on the 2015 EML, 145 fit the inclusion criteria of this analysis. Active pharmaceutical ingredient data were available for 96 of these 145 medicines (66%)(an example of these data for a single medicine is illustrated in Appendix Figure A1).

estimated cost-based prices

Estimated cost-based prices ranged from \$0.24 (salbutamol 50mcg) to \$449 (rituximab 500mg).

The comparison of lowest current prices in England, South Africa, and India to estimated cost-based prices for injectable items is shown in Table 1 and Figure 2. The majority of injectable items had prices significantly above the estimated cost-based prices in England and South Africa, however, in India, 88% of injectable items had prices below the estimated cost-based price.

The items with the highest ratios of lowest current price to estimated cost-based price are shown for England in Table 2, for South Africa in Table 3, and for India in Table 4.

Therapeutic categories with notably higher ratios of lowest current price to estimated cost-based price included cardiovascular medicines, medicines for mental and behavioural disorders, hormones, other endocrine medicines and contraceptives, anticonvulsants/antiepileptics, antineoplastics and immunosuppressives, and oxytocics (appendix).

International price comparisons

International comparisons of lowest current prices for injectable essential medicines are shown in Figure 3. Prices were higher in England than in South Africa in 60% of comparisons, with a median ratio of 1.44; higher in England than in India in 91% of comparisons, with a median ratio of 7.08; and higher in South Africa than in India in 84% of comparisons, with a median ratio of 3.69 (Figure 3).

DISCUSSION

For injectable formulations on the WHO EML, 77% of medicines had prices above the estimated cost-based price in England, and 62% has prices above the estimated cost-based price in South Africa, while 85% of medicines in India were below estimated cost-based price. 19% of injectable medicines in England, 9% in South Africa, and 5% in India had prices more than 10 times the estimated cost-based price (Table 1, Figure 2).

A few medicines were notable for appearing in the top-20 lists by ratio of current price to estimated cost-based price in more than one country (Tables 2–4): numerous oncology medicines – irinotecan, ifosfamide, daunorubicin, filgrastim, and mesna – as well as the certain antimicrobials (ampicillin, acyclovir, quinine), valproic acid (an anti-epileptic) and ciclosporin (an immunosuppressant).

A wide range of market factors may contribute to the greater than average difference in manufacture costs and price. The ‘top 20’ injectable medicines are all mostly used in the in-patient hospital setting, are used in specialist treatments, are second/third-line treatments, and/or are used for short durations. These characteristics would all tend to reduce demand volumes, reduce economies of scale (both in manufacture and distribution), and reduce the buyer’s negotiating power, and may thus explain the high prices relative to manufacture costs.

Differences between countries in the ratios of lowest current price to estimated cost-based generic price, similarly, may be explained by a wide range of factors. A detailed comparison of pharmaceutical market characteristics of the three countries is beyond the scope of the study. India is a substantially larger market than England and South Africa, and this difference in volume of demand may play a role. Differences in regulatory requirements are also likely to play a significant role. India has a large local generic manufacturing sector. Lastly, there may be a comparatively greater emphasis on these ‘essential’ products in South Africa and India compared to England, as there is in general a lesser range of products available for use, for most patients in these countries. Lastly, some of the higher-cost drugs for which prices were identified for England were not found in the Indian databases, which leads to a degree of ‘selection bias’, wherein for the India comparison, a higher proportion of available datapoints are for lower-cost drugs than for the UK.

Most of all of the medicines compared in this analysis are no longer under patent protection in England, South Africa, or India.[16] Varying levels of competition across products and countries may

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3 also influence prices. This analysis does not account for differing volumes related to market size and
4 related efficiencies. In many or most cases, we would not expect low competition to be a driving
5 factor behind high prices, given the robust generics markets in England, South Africa, and India, as
6 well as the 'essential' nature of included medicines. However, in some cases, high prices for generic
7 medicines may be explained by anti-competitive practices, or price hikes where a single supplier
8 controls the market. This analysis is unable to detect the presence of anticompetitive strategies
9 which may raise prices such as price fixing or upstream consolidation or collusion. The extent of
10 these practices is unknown, but, as this year's lawsuit brought by 44 state Attorney Generals in the
11 US against 20 generics manufacturers demonstrates, anticompetitive practices may be prevalent in
12 certain pharmaceutical markets.[17]
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22 Given the range of medicines included, it is difficult to make generalised comments. If cost of
23 manufacture analysis were employed by governments to evaluate prices, large differences between
24 current prices and estimated cost-based prices could trigger closer examination on a case-by-case
25 basis. For example, linezolid is recently off-patent, and is used as a 'last-resort' antibiotic,[18]
26 limiting demand volume. Some EML medicines, such as filgrastim , which appears in the 'top 20' in
27 all three countries , are biologics, meaning different regulations and higher regulatory expenses may
28 apply. In such cases, large profit margins may be more acceptable. In other cases, such as ibuprofen
29 (5mg in 1mL injection) and ampicillin (1000mg powder for injection) in England may reflect
30 insufficient competition, inefficient procurement, or a less commonly used dosage form (Table 2).
31 Some of these 'top 20' medicines may represent a substantial burden on healthcare expenditures –
32 for example, irinotecan represented expenditures of £22 million (about US\$29 million) by the public
33 healthcare system in England in 2016/2017.[19]
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42 Current lowest prices in India were on average lower than our estimated cost-based prices (lowest
43 current prices in India were median 27% of the estimated cost-based price; Table 1 and Figure 2).
44 This may reflect conservative assumptions made for the cost of ampoules and vials; a substantial
45 number of items cost less than our assumed raw material cost for the ampoule/vial (primary
46 packaging) alone, which we based on prices in high-income countries (see Figure A2 in the
47 Appendix). It may also reflect the general conservative (overestimating) effect of using data on
48 exported active pharmaceutical ingredient; active pharmaceutical ingredient that is manufactured
49 in-house or procured domestically may have lower prices. The use of an average active
50 pharmaceutical ingredient price (rather than, for example, lowest observed or first-quartile) means,
51 in most cases, that a number of active pharmaceutical ingredient sales occurred at lower price
52 points. Lastly, Indian prices were collected from two databases – one representing the private
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3 market and one representing Tamil Nadu state tenders (the lower price of the two was recorded).
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5 State tender prices are likely lower than private market prices, but the majority of health
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7 expenditures in India are out-of-pocket, and of these the majority are on medicines.[20] In addition,
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9 there are wide variations in wealth and access to health insurance between Indian states. The
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11 methodological approach of seeking the lowest available price in each country means that the price
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13 faced by patients when paying out-of-pocket in the private market may be considerably higher.

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15 In our earlier analysis of solid oral form medicines in the EML, we found that 77% comparable prices
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17 in England, 67% comparable prices in South Africa and 40% comparable prices in India were above
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19 the estimated cost-based price. Median ratios for lowest current price to estimated cost-base price
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21 were 2.7x in England, 1.4x in South Africa, and 0.6x in India.[3] These ratios are notably similar to the
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23 comparisons in this analysis between lowest current prices and estimated cost-based prices for
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25 injectables (2.5x in England, 1.5x in South Africa, 0.3x in India; Table 1).

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27 Analysis of the cost of production of medicines can be used in government price negotiations, price
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29 control mechanisms, or in competition law contexts. In India, until 2013, a formula based on the cost
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31 of manufacture was used to set ceiling prices on key medicines.[21,22] A similar approach is or has
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33 been used in Bangladesh, Pakistan, and China.[22] In South African tenders, manufacturers are
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35 required to submit breakdowns of their price by various cost components including active
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37 pharmaceutical ingredient cost and profit margin.[23] The WHO Guideline on Pharmaceutical Pricing
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39 Policies notes that the use of cost-plus formulae may be challenging to implement due to challenges
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41 on obtaining accurate data on material prices on manufacturing costs, and due to the potential for
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43 manipulation of data by manufacturers to exaggerate costs and justify higher prices.[22] Indeed, in
44
45 this analysis, the Indian government requirement for the publication of customs data on the value of
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47 exported active pharmaceutical ingredient has been revoked since we collected data, meaning that
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49 at present the authors are not aware of an alternative, affordable source of data for active
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51 pharmaceutical ingredient costs.[24] Nevertheless, cost of manufacture analysis should be explored
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53 further as a component of pricing policies.

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55 Pricing policies linked to manufacturer costs would also need to be use alongside policies to prevent
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57 shortages and stock-outs.[25] Indeed, some of the therapeutic groups identified in this analysis as in
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59 many cases high differences between market prices and estimated cost-based prices, such as
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61 chemotherapy medicines and antibiotics, may also be groups that are vulnerable to
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63 shortages.[26,27]

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5 This study, which used broad and conservative assumptions, can be seen as an initial exploration of
6 the feasibility of estimating cost-based generic prices for injectables. As there is considerable
7 variation among items listed in the EML, a tailored approach could be to improve the precision and
8 confidence of the estimate for specific products, for example, those identified here as having high
9 price-to-cost ratios.
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14 **limitations**

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17 The main limitation of our analysis is that our estimates do not account for differences of costs
18 across individual manufacturing plants due to heterogeneity in, for example, location, machinery
19 used, and capacity, as well as different distribution costs (including tariffs) depending on the country
20 of manufacture and the importing country, and changes in conversion cost depending on the volume
21 of the unit. As argued above, this limitation would not preclude the use of a methodology such as
22 this one to identify medicines that may have high profit margins, for closer *ad hoc* analysis.
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26 Although prices in India were adjusted to be net of VAT, other state-level taxes may apply and these
27 were not adjusted for.
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31 In the previous analysis concerning solid oral formulations on the WHO EML, in which many
32 elements of the methodology were identical (e.g. cost analysis for active pharmaceutical ingredient,
33 tax and profit assumptions), the estimated cost-based generic prices were compared to the lowest
34 available prices for key HIV, TB, and malaria treatments. Prices in these disease areas were used, as
35 there are well-developed international procurement mechanisms for quality-assured generic
36 products, and procurement prices are transparently reported. In this validation exercise, predictive
37 accuracy between estimated cost-based generic price and actual global market prices was high.[28]
38
39 However, medicines for HIV, TB, and malaria are predominantly solid oral formulations. We have
40 thus not attempted to conduct a similar validation exercise for the estimated cost-based prices
41 presented in this study, for lack of a dataset to be used for comparison. As noted, however, we
42 consider the individual assumptions made for cost components to be conservative (high).
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51 As data collection for this analysis finished shortly before the publication in April 2017 of the 2017
52 EML. The EML is published biennially; we used the most recent iteration at the time of data analysis,
53 the 2015 EML.
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58 **conclusion**

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3 Most injectable medicines on the EML can be manufactured at very low cost. In England, about one
4 in five injectable essential medicines was priced at more than 10 times the estimated cost-based
5 price. In South Africa, this proportion was about one in ten, and in India, about one in twenty.
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7 Estimation of the cost of manufacture could be used in government pharmaceutical pricing
8 mechanisms, for example, by identifying products for which profit margins may be notably above
9 average.
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AUTHORS' CONTRIBUTIONS

DG, MJB, and AMH designed the study, interpreted the data, and critically reviewed the manuscript. MJB and DG collected and analysed the data.

COMPETING INTERESTS

Dzintars Gotham reports personal fees for unrelated work from the Medicines Patent Pool, the Wellcome Trust, Treatment Action Group, and the World Health Organization. Melissa J Barber and Andrew M Hill report no conflicts of interest.

DATA SHARING STATEMENT

Some unpublished data on active pharmaceutical ingredient costs could be shared upon request. An appendix with details on methodology is available as a supplementary file.

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3 **TABLES AND FIGURES**
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Table 1. Comparison of estimated prices and lowest current prices in England, South Africa, and India.

	England	South Africa	India
Injectables			
>10x estimated price	15 (19%)	5 (9%)	4 (5%)
0-10x estimated price	47 (58%)	31 (53%)	8 (10%)
Below estimated price	19 (23%)	22 (38%)	68 (85%)
Median ratio of current price to estimated price	2.54x	1.48x	0.30x

Note: multiple dosage levels of one formulation of one medicine (e.g. ifosfamide powder for injection in 1g and 2g forms) are counted as one instance in these overview statistics.

Table 2. Injectable essential medicines with the highest price compared to estimated cost-based price, in England.

Medicine	Unit	Lowest current price (USD)	Estimated cost-based price (USD)	Ratio
irinotecan	5mL vial (100mg)	\$143.81	\$1.17	122.7
filgrastim	1mL vial (300mcg)	\$68.52	\$0.61	112.6
ibuprofen	1mL injection (5mg)	\$46.80	\$0.61	77.3
daunorubicin	powder for injection (50mg)	\$211.25	\$2.88	73.4
azathioprine	powder for injection (100mg)	\$39.99	\$0.66	60.5
ifosfamide	powder for injection (2g)	\$233.84	\$4.10	57.1
ifosfamide	powder for injection (1g)	\$118.72	\$2.35	50.5
ifosfamide	powder for injection (500mg)	\$59.35	\$1.48	40.2
mesna	10mL ampoule (1000mg)	\$38.23	\$1.13	33.9
atropine	1mL ampoule (1mg)	\$8.25	\$0.24	33.7
ampicillin	powder for injection (1000mg)	\$20.36	\$0.64	31.6
mesna	4mL ampoule (400mg)	\$17.43	\$0.60	29.2
phenobarbital	1mL injection (200mg)	\$7.32	\$0.26	27.7
epinephrine	10mL ampoule (1mg)	\$6.97	\$0.27	26.1
valproic acid	4mL ampoule (400mg)	\$5.09	\$0.26	19.9
zidovudine	20mL vial (200mg)	\$11.60	\$0.67	17.3
ampicillin	powder for injection (500mg)	\$10.18	\$0.62	16.3
irinotecan	25mL vial (500mg)	\$46.83	\$3.44	13.6
ketamine	10mL vial (500mg)	\$9.10	\$0.79	11.4
hydralazine	powder for injection (20mg)	\$2.88	\$0.25	11.4

Table 3. Injectable essential medicines with the highest price compared to estimated cost-based price, in South Africa.

Medicine	Unit	Lowest current price (USD)	Estimated cost-based price (USD)	Ratio
filgrastim	1mL vial (300mcg)	\$32.38	\$0.61	46.3
tranexamic acid	10mL ampoule (1000mg)	\$8.47	\$0.37	23.0
ifosfamide	powder for injection (1g)	\$28.71	\$2.35	12.2
ifosfamide	powder for injection (2g)	\$48.71	\$4.10	11.9
ifosfamide	powder for injection (500mg)	\$17.22	\$1.48	11.7
streptokinase	powder for injection (15.6mg)	\$223.93	\$19.60	11.4
amiodarone	ampoule (150mg/3mL)	\$2.87	\$0.27	10.7
digoxin	2mL ampoule (500mcg)	\$2.44	\$0.25	9.9
fluphenazine	1mL ampoule (25mg)	\$2.30	\$0.32	7.1
oxaliplatin	powder for injection (100mg)	\$59.76	\$9.10	6.6
oxaliplatin	powder for injection (50mg)	\$29.88	\$4.85	6.2
magnesium sulfate	10mL ampoule (5g)	\$1.36	\$0.26	5.2
ciclosporin	1mL ampoule (50mg)	\$1.72	\$0.33	5.2
docetaxel	injection (20mg)	\$21.70	\$4.21	5.1

docetaxel	injection (40mg)	\$34.29	\$7.82	4.4
mesna	4mL ampoule (400mg)	\$2.40	\$0.60	4.0
daunorubicin	powder for injeciton (50mg)	\$10.03	\$2.88	3.5
vincristine	powder for injection (5mg)	\$13.92	\$4.15	3.4
aciclovir	powder for injection (250mg)	\$2.10	\$0.63	3.3
quinine	2mL ampoule (600mg)	\$1.10	\$0.34	3.2

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Table 4. Injectable essential medicines with the highest price compared to estimated cost-based price , in India.

Medicine	Unit	Lowest current price (USD)	Estimated cost-based price (USD)	Ratio
irinotecan	25mL vial (500mg)	\$107.14	\$3.44	31.1
filgrastim	1mL vial (300mcg)	\$15.71	\$0.61	25.8
irinotecan	5mL vial (100mg)	\$21.43	\$1.17	18.3
irinotecan	2mL vial (40mg)	\$10.71	\$0.83	12.9
bendamustine	2mL injection (180mg)	\$185.14	\$15.05	12.3
bendamustine	0.5mL injection (45mg)	\$46.29	\$4.22	11.0
valproic acid (sodium valproate)	10mL ampoule (1g)	\$2.86	\$0.28	10.3
ciclosporin	1mL ampoule (50mg)	\$1.71	\$0.33	5.2
testosterone	1mL ampoule (200mg)	\$1.34	\$0.27	4.9
valproic acid (sodium valproate)	4mL ampoule (400mg)	\$1.14	\$0.26	4.5
insulin injection (soluble)	10mL injection (34.7mg)	\$5.80	\$2.15	2.7
sodium nitroprusside	powder for injection (50mg)	\$0.64	\$0.25	2.5

All other items for which ratios could be calculated had ratios below 2.0.

Figure 1. Formula for estimating cost-based prices for injectable formulations.

Figure 2. Estimated generic prices and current prices for injectables in England, South Africa, and India.

Figure 3. Comparison of lowest current prices of injectable essential medicines between England, South Africa, and India.

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Cost of API per kilogram

Multiply by mass of API needed for one dosage unit

If applicable, multiply by [MW/dosage in one unit] to adjust for salt forms

Multiply by 1.1 to account for 10% loss of API during formulation and overfill

Total cost of production per unit

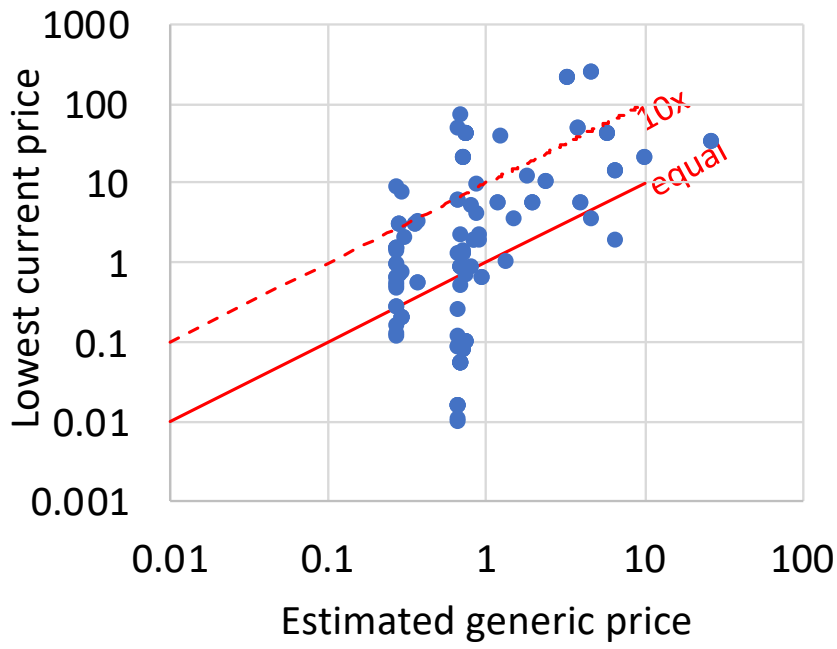
Add \$0.20 for ampoule/\$0.50 for vial for cost of materials and formulation

Add costs associated with transportation 10%

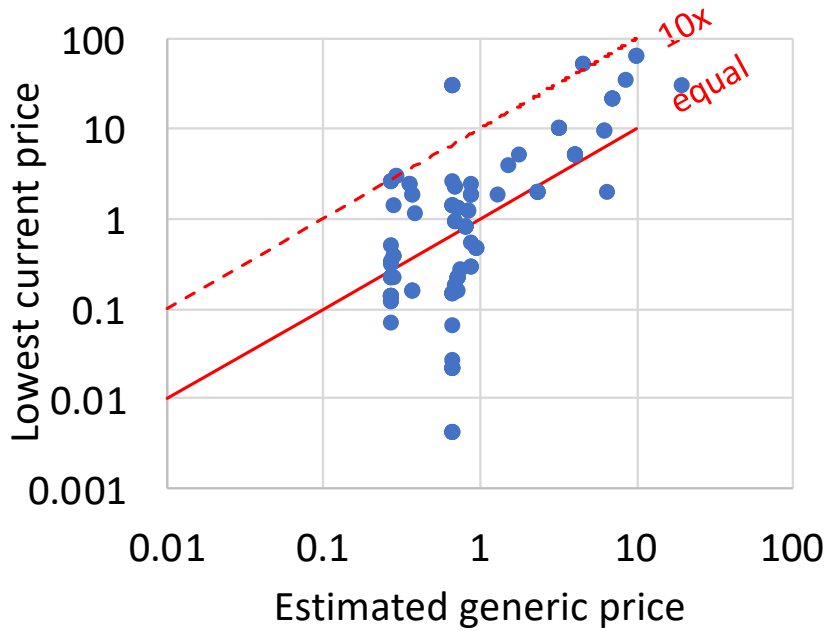
Add profit margin of 10%

Estimated cost-based price

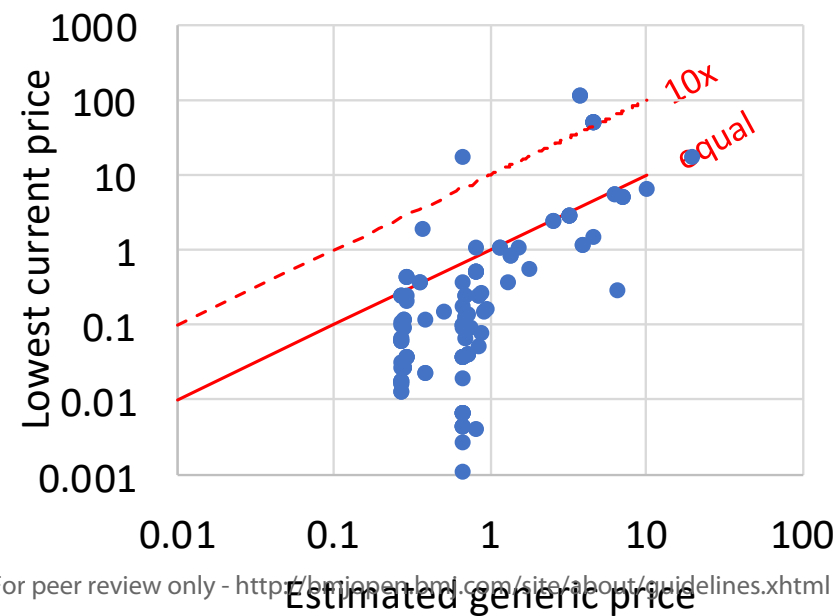
UK



South Africa

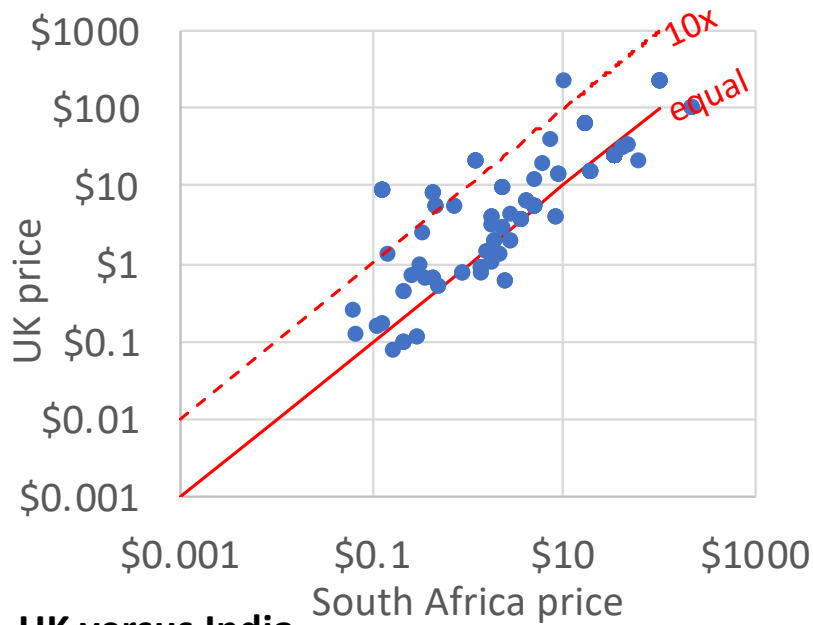


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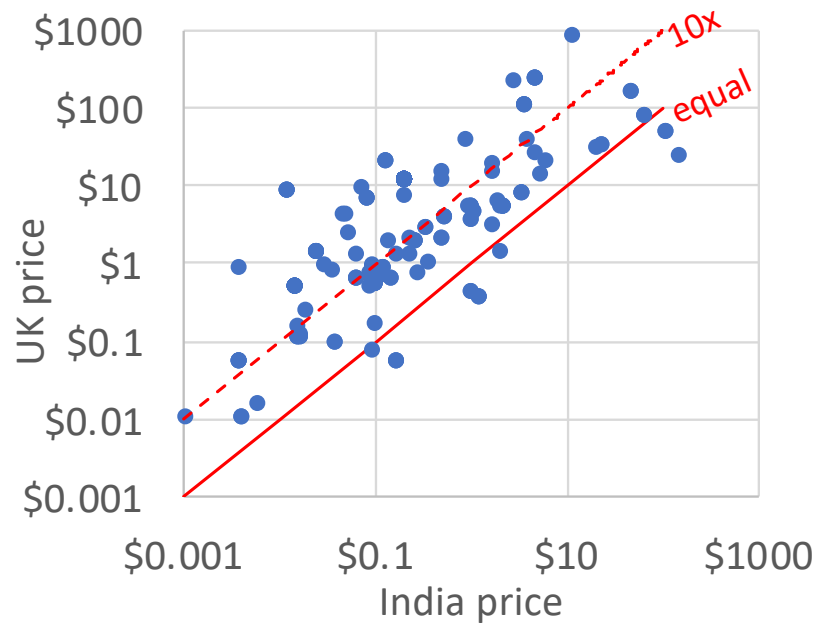


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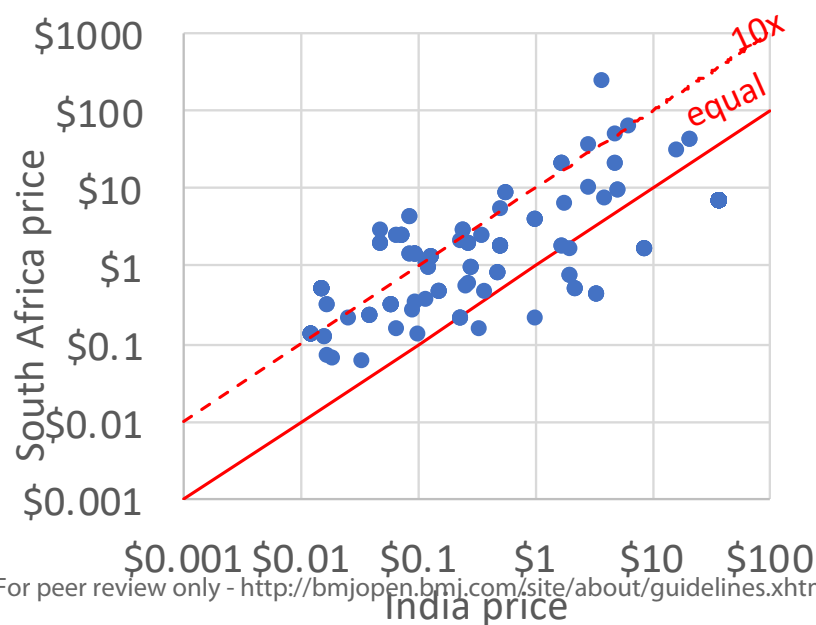
UK versus South Africa



UK versus India



South Africa versus India



Appendix

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Criteria used for cleaning export data.

Reason for censoring	Example of product description that would trigger censoring
Incorrect substance identified	"DIAMORPHINE" (in a search for "morphine")
Item is part of a mix of products	"ABACAVIR, LOPINAVIR, LAMIVUDINE API"
Quantity of shipment < 1.0 kg, with exceptions made for very low-dose medicines	Value listed in "quantity" variable greater than 1.0kg
Finished Pharmaceutical Product (FPP), for example tablets	"ABACAVIR SULFATE TABLETS 600MG"
Impurity	"ABACAVIR SULPHATE IMPURITY"
Unclear quantity of API	"ABACAVIR GRANULES 10%" (In this example, the percentage descriptor could refer to a variety of parameters, for example, moisture content. As this is not specified, the true amount of API is unknown.)
Free sample or 'no commercial value'	"ABACAVIR SULPHATE FREE SAMPLE" "ABACAVIR SULPHATE N.C.V."
For veterinary use	"IVERMECTIN VETERINARY"
Reference/working standard	"ABACAVIR WORKING STANDARD"

This table is reproduced from an earlier publication as this element of the methodology was identical:

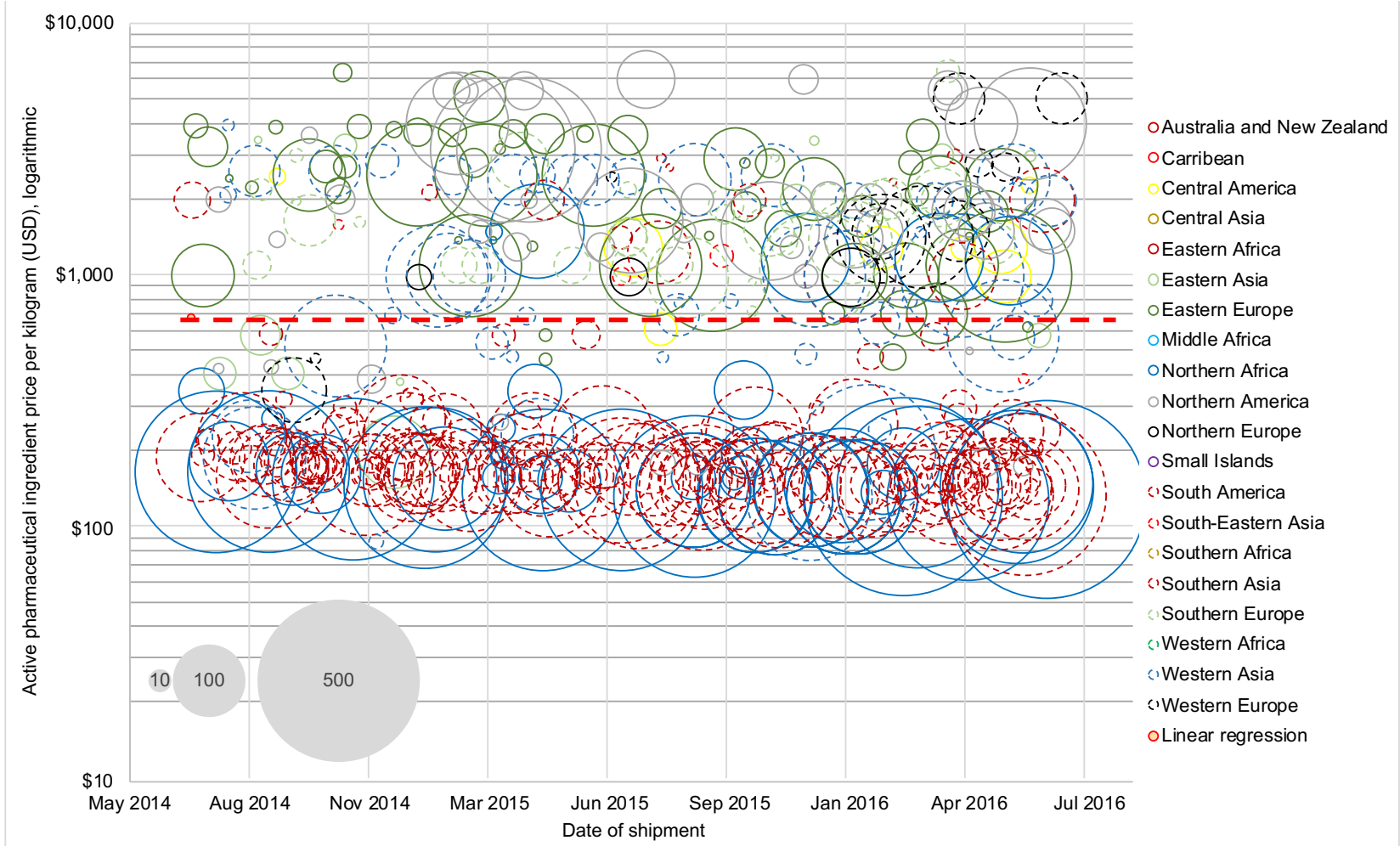
Hill A, Barber MJ, Gotham D. Estimated costs of production and potential prices for the WHO Essential Medicines List. *BMJ Global Health* 2018; e000571.

Included and excluded formulation types, by terms used in WHO Model List of Essential Medicines.

Included:
Concentrate for injection, depot injection, infusion, injectable solution, injection, injection for intravenous administration, injection for spinal anaesthesia, injection in oil, injection: ampoule or pre-filled syringe, injections, oily injection, oily solution, oily suspension for injection, parenteral formulation, powder for injection, solution for injection, solution for intramuscular injection, solution for IV infusion, vial.
Excluded:
Ampoule (for buccal administration when solution for oromucosal administration is not available), aqueous solution*, bag for infusion, capsule, cream, cream (as mupirocin calcium), cream or lotion, cream or ointment, dental cartridge, detergent-based suspension, eye ointment, gel or rectal solution, granules, granules (slow-release; to mix with water), immediate release capsule, inhalation (aerosol), lotion, lozenge, metered dose inhaler (aerosol), nasal spray, ointment, oral liquid, oral powder, pessary, powder for oral administration, powder for oral liquid, pre-filled syringe, rectal dosage form, rectal solution, respirator solution for use in nebulizers, retention enema, saturated solution, solid oral dosage form, solid oral dosage form (controlled-release tablets), solid oral form, solution, solution (eye drops), solution for oromucosal administration, suppository, tablet, tablet (chewable), tablet (crushable), tablet (dispersible, scored), tablet (dispersible), tablet (enteric-coated), tablet (heat stable), tablet (immediate release), tablet (scored), tablet (slow release), tablet (sublingual), topical, topical forms, transdermal patches, vaginal cream, vaginal tablet.

*this represents potassium permanganate for topical use in dermatology.

Figure A1. Example of API data: Price of linezolid API exported from India from July 1, 2014 to July 1, 2016.



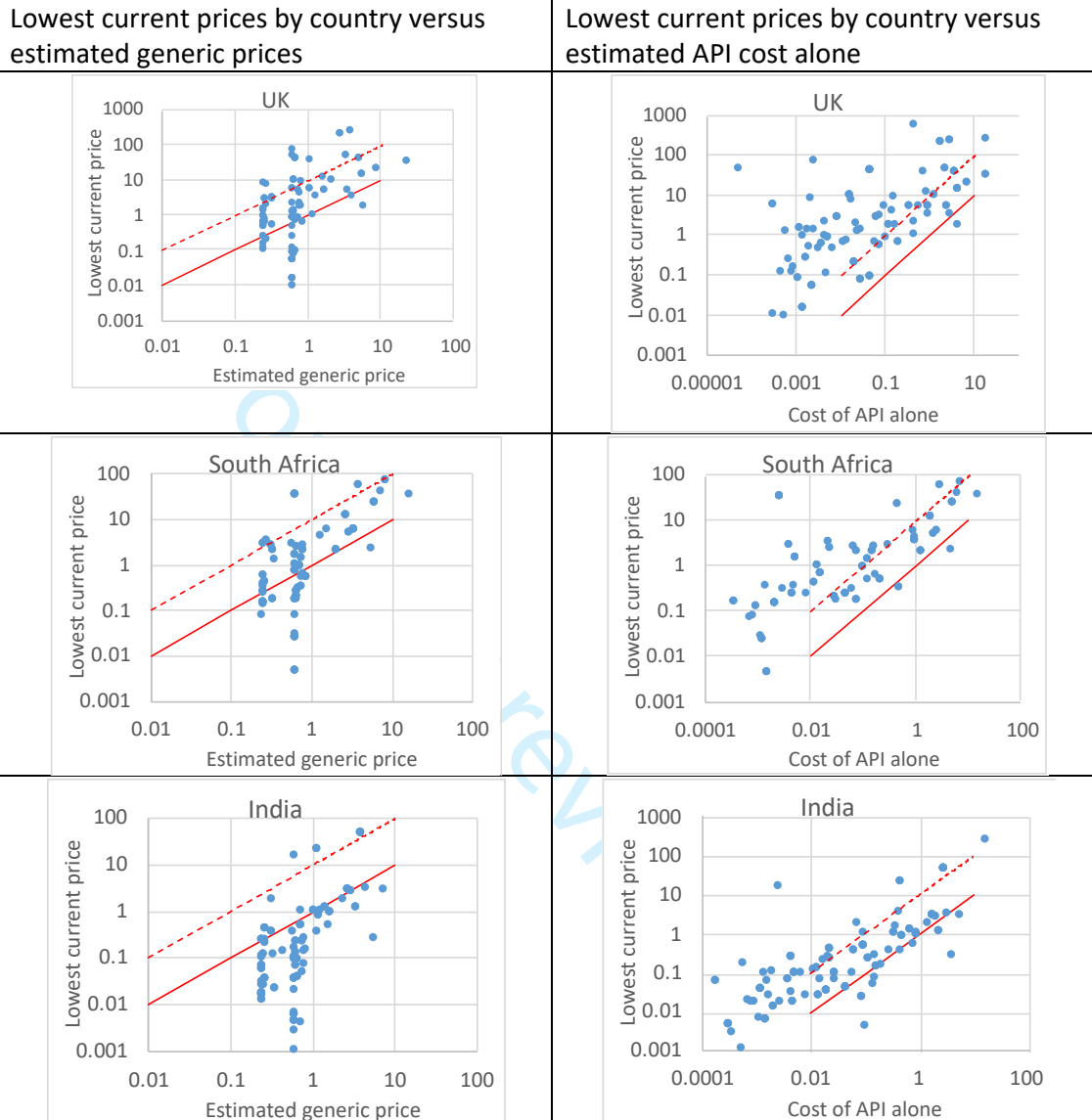
Bubble colours correspond to the region of the destination country for individual shipments. Bubble sizes correspond to the size of individual shipments (size key shown in lower-left, in kilograms). The linear regression model is shown as a dashed red line; though it appears horizontal it has a slight upwards slope. The values estimated by the linear regression model were \$683/kg on July 1, 2014, and \$690/kg on July 1, 2016.

Costs prescribed in India's Drug Price Control Order (2012).

Item	Cost per unit in 2011 Indian rupees	Converted to 2016 USD
Conversion cost		
<i>Ampoules</i>		
Up to 1mL	0.4253	\$0.008
100mL	1.4327	\$0.028
<i>Sterile vials</i>		
Up to 5mL	1.22	\$0.024
100mL	3.21	\$0.063
Packing materials cost		
<i>USP type I glass vial including blister</i>		
Up to 2mL	1.48	\$0.029
100mL	6.96	\$0.136
<i>Plastic vial/bottle</i>		
Up to 2mL	0.99	\$0.019
100mL	2.96	\$0.058
<i>Ampoules</i>		
<i>White ampoule in tray</i>		
Up to 1mL	0.53	\$0.010
25mL	2.86	\$0.056
<i>Amber ampoules in blister</i>		
Up to 1mL	0.63	\$0.012
25mL	4.68	\$0.091
Packing charges		
<i>Ampoules</i>		
Up to 5mL	0.33	\$0.006
Over 15mL	0.56	\$0.011
<i>Liquid in vials</i>		
Up to 5mL	0.6	\$0.012
Over 5mL	0.69	\$0.013
<i>Sterile powder in vials</i>		
Up to 1g	0.23	\$0.004
Over 1g	0.38	\$0.007
Ampoules range		\$0.03–\$0.13
Vials range		\$0.05–\$0.21

Pharmabiz.com. NPPA notification dated Dec 27, 2012 fixing/revising the norms for conversion cost (CC), packing charges (PC), process loss (PL) and packing material. Available from: <http://pharmabiz.com/PrintArticle.aspx?aid=72988> (accessed 6 November 2018).

Rupee values were inflation-adjusted by a factor of 1.30, based on inflation data provided by the World Bank, available from <https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=IN>.

Figure A2. Injectable target prices versus injectable API cost alone (all USD).

Solid red line: Points above this line represent an instance where the lowest current price is greater than the estimated generic price/API cost.

Dashed red line: Points above this line represent an instance where the lowest current price is more than 10 times the estimated generic price/API cost.

'Floors' can be seen for estimated generic price at \$0.24 and \$0.61 – the cost-based prices estimated by our algorithm for ampoules and vials, respectively, if API costs are zero, therefore, the estimated cost-based price cannot be below these 'floors'. In all countries, it can be observed that in some cases (in India more than in South Africa more than in UK) lowest current prices go below these 'floors'.

Ratio of estimated cost-based prices to lowest current prices in the UK, South Africa, and India, by therapeutic category.

Medicine	UK	South Africa	India
Specific medicines for neonatal care	43.4	0.8	0.1
Cardiovascular medicines	5.2	9.9	0.2
Medicines for mental and behavioural disorder	5.7	7.1	0.1
Hormones, other endocrine medicines and contraceptives	4.5	0.8	2.8
Anticonvulsants/antiepileptics	2.8	3.7	0.3
Antineoplastics and immunosuppressives	3.0	2.7	0.7
Oxytocics and antioxytocics	3.7	1.3	0.4
Antidotes and other substances used in poisonings	2.5	1.4	0.4
Anti-infectives	2.0	1.4	0.3
Gastrointestinal medicines	1.3	1.0	0.1
Muscle relaxants (peripherally-acting) and cholinesterase inhibitors	1.6	0.5	0.1
Antiallergics and medicines used in anaphylaxis	0.7	0.9	0.1
Medicines acting on the respiratory tract	0.7	NA	0.1
Medicines affecting the blood	0.6	0.5	0.1
Medicines for pain and palliative care	0.6	0.5	0.1
Anaesthetics	0.2	0.2	0.1
Diuretics	0.3	0.1	0.0
Antimigraine medicines	NA	NA	NA
Antiparkinsonism Medicines	NA	NA	NA
Dermatological Medicines (topical)	NA	NA	NA
Ophthalmological Preparations	NA	NA	NA
Ear, nose and throat medicines (children)	NA	NA	NA
Medicines for diseases of joints	NA	NA	NA

Table is ranked by highest to lowest mean ratio across the three countries.

Full results table: Lowest current prices in the UK, South Africa, and India, and estimated cost-based generic prices.

Medicine	Unit	UK price (USD)	UK price source	South Africa price (USD)	India price (USD)	India price source	Cost of API per unit	Estimated cost-based product price per unit
acetylcysteine	2000mg ampoule	\$1.36	eMIT	\$1.57	\$2.00	TN		
aciclovir	powder for injection (250mg)	\$1.24	eMIT	\$2.10	\$0.23	TN	\$0.02215	\$0.63448
amikacin	powder for injection (1000mg)	\$23.83	eMIT	\$0.55	\$0.27	TN		
amikacin	powder for injection (100mg)	\$2.38	eMIT	\$0.33	\$0.05	TN		
amikacin	powder for injection (500mg)	\$11.92	eMIT	\$0.28	\$0.14	TN		
amiodarone	ampoule (150mg/3mL)	\$1.95	BNF	\$2.87	\$0.24	TN	\$0.02024	\$0.26893
amphotericin B	powder for injection (50mg)	\$5.04	BNF		\$1.02	TN	\$0.09296	\$0.72872
ampicillin	powder for injection (1000mg)	\$20.36	BNF	\$1.21	\$0.13	TN	\$0.02941	\$0.64415
ampicillin	powder for injection (500mg)	\$10.18	BNF	\$0.61	\$0.06	TN	\$0.01471	\$0.62457
artemether	ampoule (80mg/1mL)				\$0.40	P	\$0.02194	\$0.27120
artesunate	artesunate ampoule (60mg) & 5% sodium bicarbonate ampoule							
asparaginase	powder for injection (10,000iU)	\$796.90	BNF		\$11.57	TN		
atracurium	1mL injection (10mg)	\$0.86	BNF		\$0.00	TN	\$0.09646	\$0.73339
atropine	1mL ampoule (1mg)	\$8.25	BNF	\$0.13	\$0.01	TN	\$0.00198	\$0.24464
azathioprine	powder for injection (100mg)	\$39.99	BNF				\$0.04225	\$0.66124
bendamustine	2mL injection (180mg)				\$185.14	P	\$10.85220	\$15.04928
bendamustine	0.5mL injection (45mg)				\$46.29	P	\$2.71305	\$4.21607
benzathine benzylpenicillin	5mL vial (1.44g)				\$0.23	P		
benzathine benzylpenicillin	5mL vial (900mg)				\$0.17	P		
benzylpenicillin	powder for injection (3g)	\$15.18	BNF		\$0.49	TN		
benzylpenicillin	powder for injection (600mg)	\$3.04	BNF		\$0.10	TN		
bevacizumab	1mL injection (25mg)	\$78.86	BNF		\$63.57	TN		
biperiden	1ml ampoule (5mg)							
bleomycin	powder for injection (15mg)	\$24.78	BNF		\$4.60	TN		
bupivacaine	1mL injection (2.5mg)	\$0.11	eMIT		\$0.02	P	\$0.00051	\$0.60568
bupivacaine	4mL ampoule (20mg, with glucose)			\$0.21	\$0.23	P	\$0.00411	\$0.24747
bupivacaine	1mL injection (5mg)	\$0.09	eMIT	\$0.02	\$0.01	TN	\$0.00103	\$0.60637
caffeine citrate	1mL injection (20mg)	\$5.70	eMIT				\$0.00030	\$0.60540
calcium folinate	10mL ampoule (30mg)	\$6.01	BNF		\$1.87	P		
calcium gluconate	10mL ampoule (1000mg)	\$0.65	eMIT	\$0.36	\$0.11	P	\$0.01106	\$0.25672
capreomycin	powder for injection (1000mg)	\$37.19	BNF	\$7.16	\$3.93	P		
carboplatin	60mL injection (600mg)	\$32.83	eMIT	\$45.76	\$22.80	TN	\$17.23615	\$23.54631
carboplatin	15mL injection (150mg)	\$9.91	eMIT	\$11.44	\$5.70	TN	\$4.30904	\$6.34033

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3	carboplatin	45mL injection (450mg)	\$24.78	eMIT	\$30.01	\$15.81	TN	\$12.92711	\$17.81099
4	carboplatin	5mL injection (50mg)	\$4.64	eMIT	\$3.81	\$1.76	TN	\$1.43635	\$2.51678
5	cefazolin	powder for injection (1000mg)			\$0.53	\$0.26	TN	\$0.15187	\$0.80714
6	cefotaxime	powder for injection (250mg)	\$1.31	eMIT	\$0.15	\$0.06	TN	\$0.02734	\$0.64139
7	ceftazidime	powder for injection (1000mg)	\$0.99	eMIT	\$1.77	\$0.36	P	\$0.43097	\$1.17863
8	ceftazidime	powder for injection (250mg)	\$1.77	eMIT	\$0.44	\$0.36	P	\$0.10774	\$0.74841
9	ceftriaxone	powder for injection (1000mg)	\$0.64	eMIT	\$0.44	\$0.15	TN	\$0.19035	\$0.85836
10	ceftriaxone	powder for injection (250mg)	\$1.43	eMIT	\$0.27	\$0.08	TN	\$0.04759	\$0.66834
11	chloramphenico								
12	l	2mL ampoule (1000mg)				\$0.14	P	\$0.15906	\$0.45370
13	chloramphenico								
14	l	powder for injection (1000mg)	\$1.81	BNF		\$0.14	P	\$0.15906	\$0.81670
15	chlorpromazine	2mL ampoule (50mg)	\$0.92	eMIT		\$0.03	P	\$0.00429	\$0.24772
16	chlorpromazine	2mL ampoule (50mg)	\$0.92	eMIT		\$0.03	P	\$0.00429	\$0.24772
17	ciclosporin	1mL ampoule (50mg)	\$3.02	BNF	\$1.72	\$1.71	P	\$0.06771	\$0.33212
18	ciprofloxacin	1mL solution for infusion (2mg)	\$0.01	eMIT		\$0.00	TN	\$0.00051	\$0.60568
19	cisplatin	100mL injection (100mg)	\$13.73	eMIT	\$8.84	\$5.14	P	\$3.88629	\$5.77765
20	cisplatin	50mL injection (50mg)	\$9.09	eMIT	\$4.42	\$2.57	P	\$1.94314	\$3.19133
21	clindamycin	1mL injection (150mg)	\$0.37	eMIT		\$1.21	P		
22	cloxacillin	powder for injection (500mg)			\$0.89	\$0.12	TN	\$0.01268	\$0.62188
23	cyclizine	1mL injection (50mg)	\$2.11	eMIT				\$0.00419	\$0.61057
24	cyclophosphami								
25	de	powder for injection (500mg)	\$11.53	eMIT	\$5.04	\$0.50	TN	\$0.78130	\$1.64490
26	cytarabine	powder for injection (100mg)	\$3.99	eMIT	\$1.80	\$0.05	TN	\$0.13341	\$0.78257
27	dacarbazine	powder for injection (100mg)	\$5.42	eMIT		\$1.01	TN	\$0.33923	\$1.05652
28	dactinomycin	powder for injection (500mcg)				\$5.87	P		
29	daunorubicin	powder for injection (50mg)	\$211.25	BNF	\$10.03	\$2.78	TN	\$1.70665	\$2.87655
30	deferoxamine	injection (500mg)	\$5.19	BNF	\$0.47	\$2.12	TN		
31	deferoxamine	powder for injection (500mg)	\$5.19	BNF	\$0.47	\$2.12	TN		
32	desmopressin	1mL ampoule (4mcg)	\$1.46	eMIT				\$0.00112	\$0.24349
33	dexamethasone	1mL ampoule (4mg)			\$0.21	\$0.02	TN	\$0.00790	\$0.25252
34	dexamethasone	1mL ampoule (4mg)			\$0.21	\$0.02	TN	\$0.00790	\$0.25252
35	dexamethasone	1mL ampoule (4mg)			\$0.21	\$0.02	TN	\$0.00790	\$0.25252
36	dexamethasone	1mL ampoule (4mg)			\$0.21	\$0.02	TN	\$0.00790	\$0.25252
37	dexamethasone	1mL ampoule (4mg)			\$0.21	\$0.02	TN	\$0.00790	\$0.25252
38	diazepam	1mL injection (5mg)	\$0.25	eMIT	\$0.06	\$0.02	TN	\$0.00065	\$0.60587
39	digoxin	2mL ampoule (500mcg)	\$0.60	eMIT	\$2.44	\$0.06	P	\$0.00354	\$0.24671
40	dimercaprol	2mL ampoule (100mg)				\$1.50	P		
41	docetaxel	injection (20mg)	\$3.30	eMIT	\$21.70	\$1.45	TN	\$2.71104	\$4.21340
42	docetaxel	injection (40mg)			\$34.29	\$2.90	TN	\$5.42209	\$7.82180
43	dopamine	5mL vial (200mg)	\$0.68	eMIT	\$0.26	\$0.09	TN	\$0.05528	\$0.67858
44	doxorubicin	powder for injection (10mg)	\$1.99	eMIT	\$1.70	\$0.50	TN	\$0.45249	\$1.20727
45	doxorubicin	powder for injection (50mg)	\$5.25	eMIT	\$5.06	\$1.13	TN	\$2.26247	\$3.61635
46	eflornithine	100mL injection (20g)						\$27.83990	\$37.65990
47	ephedrine	1mL ampoule (30mg)	\$0.52	eMIT		\$0.10	TN	\$0.00184	\$0.24445
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3	epinephrine	10mL ampoule (1mg)	\$6.97	eMIT				\$0.01878	\$0.26699
4	(adrenaline)								
5	epinephrine	1mL ampoule (1mg)	\$0.20	eMIT		\$0.03	TN	\$0.01878	\$0.26699
6	(adrenaline)								
7	epinephrine	1mL ampoule (1mg)	\$0.20	eMIT		\$0.03	TN	\$0.01878	\$0.26699
8	(adrenaline)								
9	ergometrine	1ml ampoule (0.2mg)				\$0.03	P		
10	erythromycin	powder for injection (500mg)	\$11.12	eMIT					
11	estradiol								
12	cypionate +								
13	medroxyprogest								
14	erone acetate	injection (5mg + 25mg)							
15	etoposide	5mL ampoule (100mg)	\$3.47	eMIT	\$3.66	\$0.97	TN	\$0.84629	\$1.36841
16	filgrastim	1.6mL vial (480mcg)						\$0.00392	\$0.61022
17	filgrastim	1mL vial (300mcg)	\$68.52	BNF	\$28.15	\$15.71	P	\$0.00245	\$0.60826
18	fluconazole	1mL vial (2mg)	\$0.01	eMIT		\$0.00	TN	\$0.00028	\$0.60538
19	flucytosine	250mL infusion (2.5g)	\$39.43	BNF				\$3.44262	\$5.18712
20	fludarabine	vial (50mg)	\$30.46	eMIT	\$42.03	\$20.50	TN		
21	fluorouracil	5mL ampoule (250mg)	\$0.60	eMIT		\$0.10	P		
22	fluphenazine	1mL ampoule (25mg)	\$2.78	eMIT	\$2.30	\$0.34	P	\$0.05980	\$0.32160
23	fomepizole	1.5mL ampoule (1500mg)						\$26.92838	\$36.08368
24	furosemide	2mL ampoule (20mg)	\$0.12	eMIT	\$0.07	\$0.02	TN	\$0.00075	\$0.24300
25	furosemide	2mL ampoule (20mg)	\$0.12	eMIT	\$0.07	\$0.02	TN	\$0.00075	\$0.24300
26	gemcitabine	vial (1000mg)	\$40.16	eMIT	\$20.20	\$4.71	TN	\$4.36964	\$6.42099
27	gemcitabine	vial (200mg)	\$5.19	eMIT	\$5.02	\$0.94	TN	\$0.87393	\$1.76820
28	gentamicin	2mL vial (20mg)	\$1.43	eMIT		\$0.04	P		
29	gentamicin	2mL vial (80mg)	\$0.78	eMIT	\$0.23	\$0.04	TN		
30	glucagon	1mL injection (1mg)	\$14.98	BNF	\$19.51	\$1.64	P		
31	haloperidol	1mL ampoule (5mg)	\$1.40	eMIT		\$0.02	TN	\$0.00166	\$0.24420
32	haloperidol	1mL ampoule (5mg)	\$1.40	eMIT		\$0.02	TN	\$0.00166	\$0.24420
33	haloperidol	1mL ampoule (5mg)	\$1.40	eMIT		\$0.02	TN	\$0.00166	\$0.24420
34	heparin sodium	1mL ampoule (133.3mg)						\$1.69772	\$2.50167
35	heparin sodium	1mL ampoule (6.7mg)	\$0.99	eMIT	\$0.17	\$0.02	P	\$0.08533	\$0.35558
36	heparin sodium	1mL ampoule (6.7mg)	\$0.99	eMIT	\$0.17	\$0.02	P	\$0.08533	\$0.35558
37	heparin sodium	1mL ampoule (33.3mg)	\$2.09	eMIT	\$0.28	\$0.14	TN	\$0.42411	\$0.80649
38	heparin sodium	1mL ampoule (33.3mg)	\$2.09	eMIT	\$0.28	\$0.14	TN	\$0.42411	\$0.80649
39	hydralazine	powder for injection (20mg)	\$2.88	BNF				\$0.00777	\$0.25234
40	hydrocortisone	powder for injection (100mg)			\$0.78	\$0.48	P	\$0.09166	\$0.72700
41	hydrocortisone	powder for injection (100mg)			\$0.78	\$0.48	P	\$0.09166	\$0.72700
42	hydroxocobala								
43	min	1mL ampoule (1mg)	\$1.15	eMIT					
44	hyoscine								
45	hydrobromide	injection (600mcg)	\$1.33	eMIT				\$0.00239	\$0.24518
46	hyoscine								
47	hydrobromide	injection (400mcg)	\$1.10	eMIT				\$0.00159	\$0.24412
48	ibuprofen	1mL injection (5mg)	\$46.80	BNF				\$0.00005	\$0.60507
49	ifosfamide	powder for injection (1g)	\$118.72	BNF	\$28.71	\$2.33	TN	\$1.31204	\$2.35133
50	ifosfamide	powder for injection (2g)	\$233.84	BNF	\$48.71	\$4.65	TN	\$2.62408	\$4.09765
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1	ifosfamide	powder for injection (500mg)	\$59.35	BNF	\$17.22	\$1.16	TN	\$0.65602	\$1.47816
2									
3	imipenem + cilastatin	powder for injection (500mg + 500mg)	\$3.30	eMIT	\$3.12	\$11.86	P		
4									
5	imipenem + cilastatin	powder for injection (250mg + 250mg)			\$1.56	\$8.50	P		
6									
7	insulin injection (soluble)	10mL injection (13.9mg)				\$0.79	TN	\$0.46524	\$1.22423
8									
9	insulin injection (soluble)	10mL injection (34.7mg)	\$9.72	BNF	\$1.83	\$5.80	P	\$1.16309	\$2.15308
10									
11	intermediate-acting insulin	10mL injection (13.9mg)				\$0.79	TN		
12									
13	intermediate-acting insulin	10mL injection (34.7mg)	\$9.72	BNF	\$1.83	\$4.19	P		
14									
15	irinotecan	5mL vial (100mg)	\$143.81	BNF		\$21.43	P	\$0.42618	\$1.17225
16									
17	irinotecan	25mL vial (500mg)	\$46.83	eMIT		\$107.14	P	\$2.13090	\$3.44123
18									
19	irinotecan	2mL vial (40mg)	\$5.58	eMIT		\$10.71	P	\$0.17047	\$0.83190
20									
21	kanamycin	powder for injection (1g)				\$0.43	P		
22									
23	ketamine	10mL vial (500mg)	\$9.10	BNF	\$2.30	\$0.07	P	\$0.14269	\$0.79492
24									
25	lidocaine	2mL ampoule (100mg lidocaine + glucose)				\$0.06	P	\$0.00016	\$0.24222
26									
27	lidocaine	5mL ampoule (100mg)	\$0.26	eMIT		\$0.02	P	\$0.00162	\$0.24416
28									
29	lidocaine	vial (10mg)	\$0.05	BNF	\$0.40	\$0.00	P	\$0.00016	\$0.60522
30									
31	lidocaine	vial (20mg)	\$0.06	BNF	\$0.14	\$0.00	P	\$0.00032	\$0.60543
32									
33	lidocaine + epinephrine (adrenaline)	vial (10mg + 0.005mg)	\$0.13	BNF				\$0.00026	\$0.60534
34									
35	lidocaine + epinephrine (adrenaline)	vial (20mg + 0.005mg)	\$0.12	BNF				\$0.00042	\$0.60556
36									
37	lorazepam	1mL ampoule (2mg)				\$0.06	TN	\$0.00147	\$0.24395
38									
39	lorazepam	1mL ampoule (4mg)	\$0.46	BNF		\$0.21	P	\$0.00294	\$0.24591
40									
41	magnesium sulfate	10mL ampoule (5g)	\$0.73	eMIT	\$1.36	\$0.09	TN	\$0.01335	\$0.25978
42									
43	magnesium sulfate	2mL ampoule (1g)	\$0.42	eMIT	\$0.27	\$0.02	TN	\$0.00267	\$0.24556
44									
45	mannitol	1mL solution (100mg)	\$0.01	BNF		\$0.00	P	\$0.00069	\$0.60592
46									
47	mannitol	1mL solution (100mg)	\$0.01	BNF		\$0.00	P	\$0.00069	\$0.60592
48									
49	mannitol	1mL solution (200mg)	\$0.02	BNF	\$0.01	\$0.01	P	\$0.00138	\$0.60683
50									
51	mannitol	1mL solution (200mg)	\$0.02	BNF	\$0.00	\$0.01	P	\$0.00138	\$0.60683
52									
53	medroxyprogesterone acetate	1mL vial (150mg)	\$7.81	BNF	\$0.42	\$3.32	P		
54									
55	meglumine antimoniate		0						
56									
57	melarsoprol	5mL ampoule (180mg)							
58									
59	melarsoprol	5mL ampoule (180mg)							
60									
61	mesna	10mL ampoule (1000mg)	\$38.23	BNF		\$0.88	TN	\$0.66591	\$1.12833
62									
63	mesna	4mL ampoule (400mg)	\$17.43	BNF	\$2.40	\$0.35	TN	\$0.26636	\$0.59653
64									
65	methotrexate	powder for injection (50mg)	\$1.83	eMIT	\$1.93	\$0.26	TN	\$4.04570	\$5.98983
66									
67	methylprednisolone	5mL vial (200mg)						\$0.56616	\$1.35856

1	methylprednisolone	1mL vial (80mg)				\$0.61	P	\$0.22647	\$0.90643
2									
3	methylprednisolone	1mL vial (40mg)	\$1.79	eMIT	\$1.20	\$0.22	P	\$0.11323	\$0.75571
4									
5	methylthionium chloride (methylene blue)	10mL ampoule (100mg)							
6									
7	metoclopramide	2mL ampoule (10mg)	\$0.15	eMIT	\$0.11	\$0.02	TN	\$0.00086	\$0.24315
8	metoclopramide	2mL ampoule (10mg)	\$0.15	eMIT	\$0.11	\$0.02	TN	\$0.00086	\$0.24315
9	metronidazole	100mL vial (500mg)	\$0.47	eMIT		\$0.09	TN	\$0.00616	\$0.61320
10	metronidazole	100mL vial (500mg)	\$0.47	eMIT		\$0.09	TN	\$0.00616	\$0.61320
11	midazolam	1mL injection (5mg)	\$0.08	eMIT	\$0.17	\$0.09	P	\$0.02628	\$0.63998
12	midazolam	1mL injection (1mg)	\$0.11	eMIT	\$0.06	\$0.03	TN	\$0.00526	\$0.61200
13	midazolam	1mL injection (1mg)	\$0.11	eMIT	\$0.06	\$0.03	TN	\$0.00526	\$0.61200
14	morphine	1mL ampoule (10mg)	\$0.16	eMIT	\$0.13	\$0.10	TN		
15	morphine	1mL ampoule (10mg)	\$0.16	eMIT	\$0.13	\$0.10	TN		
16	naloxone	1mL ampoule (400mcg)	\$0.43	eMIT	\$0.21	\$0.99	TN		
17	neostigmine	1mL ampoule (500mcg)			\$0.26	\$0.02	TN	\$0.01352	\$0.25999
18	neostigmine	1mL ampoule (2.5mg)	\$0.53	eMIT	\$0.15	\$0.32	P	\$0.06758	\$0.33194
19	norethisterone enantate	1mL ampoule (200mg)	\$5.27	BNF	\$0.72	\$1.98	P		
20	omeprazole	powder for injection (40mg)	\$1.23	eMIT		\$0.16	TN	\$0.00055	\$0.60573
21	ondansetron	2mL ampoule (4mg)	\$0.11	eMIT	\$0.30	\$0.02	TN	\$0.00445	\$0.24792
22	ondansetron	2mL ampoule (4mg)	\$0.11	eMIT	\$0.30	\$0.02	TN	\$0.00445	\$0.24792
23	oxaliplatin	40mL vial (200mg)	\$40.30	eMIT				\$12.77141	\$17.60375
24	oxaliplatin	20mL vial (100mg)	\$20.15	eMIT	\$59.76			\$6.38571	\$9.10438
25	oxaliplatin	powder for injection (100mg)	\$20.15	eMIT	\$59.76	\$6.21	TN	\$6.38571	\$9.10438
26	oxaliplatin	powder for injection (50mg)	\$13.81	eMIT	\$29.88	\$3.10	TN	\$3.19285	\$4.85469
27	oxytocin	1mL ampoule (25mcg)	\$0.91	eMIT	\$0.32	\$0.09	TN	\$0.00134	\$0.24378
28	paclitaxel	powder for injection (1mg)	\$0.09	eMIT	\$0.22	\$0.04	TN	\$0.04273	\$0.66188
29	paromomycin	injection (750mg)							
30	pegylated interferon alfa (2a or 2b)	injection (100mcg)	\$172.80	BNF		\$48.91	TN		
31	pegylated interferon alfa (2a or 2b)	injection (180mcg)	\$161.72	BNF		\$46.43	TN		
32	pegylated interferon alfa (2a or 2b)	injection (80mcg)	\$138.24	BNF		\$39.13	TN		
33	pentamidine	powder for injection (200mg)	\$27.54	BNF					
34	phenobarbital	1mL injection (200mg)	\$7.32	eMIT		\$0.20	P	\$0.01656	\$0.26404
35	phenytoin	5mL vial (250mg)	\$0.85	eMIT	\$1.34	\$0.09	TN	\$0.00475	\$0.61133
36	phytomenadione	5mL ampoule (50mg)	\$2.46	BNF		\$0.36	P		
37	phytomenadione	5mL ampoule (5mg)							

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3	procaine benzylpenicillin	powder for injection (1g)						
4	procaine benzylpenicillin	powder for injection (3g)						
5						\$0.49	P	
6	propofol	1mL injection (20mg)	\$0.05	eMIT		\$0.17	P	\$0.00226 \$0.60800
7	propofol	1mL injection (10mg)	\$0.03	eMIT	\$0.02	\$0.03	TN	\$0.00113 \$0.60650
8	prostaglandin E1	1mL solution for injection (0.5mg)						
9	prostaglandin E2	1mL solution for injection (1mg)						
10	protamine sulfate	5mL ampoule (50mg)	\$6.44	BNF	\$4.08	\$0.08	P	
11	protamine sulfate	5mL ampoule (50mg)	\$6.44	BNF	\$4.08	\$0.08	P	
12	pyridostigmine	1mL ampoule (1mg)						
13	quinine	2mL ampoule (600mg)			\$1.10	\$0.11	P	\$0.07719 \$0.34474
14	ranitidine	2mL ampoule (50mg)	\$0.48	eMIT	\$0.49	\$0.01	TN	\$0.00105 \$0.24340
15	ribavirin	10mL solution (800mg)						\$0.09776 \$0.73512
16	ribavirin	10mL solution (800mg)						\$0.09776 \$0.73512
17	ribavirin	10mL solution (1g)						\$0.12220 \$0.76765
18	ribavirin	10mL solution (1g)						\$0.12220 \$0.76765
19	rituximab	50mL vial (500mg)	\$1,135.10	BNF	\$518.48			\$336.88802 \$449.00296
20	rituximab	10mL vial (100mg)	\$227.01	BNF	\$103.70			\$67.37760 \$90.28459
21	salbutamol	5mL ampoule (50mcg)						\$0.00001 \$0.24201
22	sodium calcium edetate	5mL ampoule (1000mg)						\$0.00334 \$0.24644
23	sodium nitrite	10mL ampoule (300mg)						\$0.00038 \$0.24250
24	sodium nitroprusside	powder for injection (50mg)				\$0.64	P	\$0.00784 \$0.25244
25	sodium stibogluconate	30mL vial (3g)	\$25.91	BNF				
26	sodium stibogluconate or meglumine antimoniate	N/A						
27	sodium thiosulfate	50mL ampoule (12500mg)						\$0.02574 \$0.27625
28	spectinomycin	powder for injection (2g)				\$2.86	P	
29	streptokinase	powder for injection (15.6mg)	\$101.97	eMIT	\$223.93	\$3.65	P	\$14.27110 \$19.59983
30	streptomycin	powder for injection (1000mg)			\$0.29	\$0.06	P	
31	streptomycin	powder for injection (1000mg)			\$0.29	\$0.06	P	
32	sulfamethoxazole + trimethoprim	5mL ampoule (400mg+80mg)	\$2.31	BNF				\$0.00659 \$0.25077
33	sulfamethoxazole + trimethoprim	5mL ampoule (400mg+80mg)	\$2.31	BNF				\$0.00659 \$0.25077
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sulfamethoxazole + trimethoprim	10mL ampoule (800mg+160mg)	\$4.62	BNF				\$0.01317	\$0.25953
suramin sodium	powder for injection (1g)							
suxamethonium		0					\$0.00000	\$0.60500
suxamethonium	2mL ampoule (100mg)	\$0.86	eMIT		\$0.12	P	\$0.05053	\$0.30925
testosterone	1mL ampoule (200mg)				\$1.34	P	\$0.02237	\$0.27178
tranexamic acid	10mL ampoule (1000mg)	\$3.90	BNF	\$8.47	\$0.54	P	\$0.09442	\$0.36767
trastuzumab	powder for injection (150mg)	\$529.62	BNF					
trastuzumab	powder for injection (440mg)							
trastuzumab	powder for injection (60mg)							
valproic acid (sodium valproate)	10mL ampoule (1g)				\$2.86	P	\$0.02628	\$0.27698
valproic acid (sodium valproate)	4mL ampoule (400mg)	\$5.09	eMIT		\$1.14	P	\$0.01051	\$0.25599
vancomycin	powder for injection (250mg)	\$0.72	eMIT	\$0.88	\$0.28	TN	\$0.22748	\$0.90777
vecuronium	powder for injection (10mg)	\$4.38	BNF		\$1.05	TN		
vecuronium	powder for injection (10mg)	\$4.38	BNF		\$1.05	TN		
verapamil	2mL ampoule (5mg)	\$1.41	BNF				\$0.00039	\$0.24252
vinblastine	powder for injection (10mg)	\$19.27	eMIT	\$6.20	\$1.72	TN	\$2.57796	\$4.03626
vincristine	powder for injection (5mg)	\$23.43	eMIT	\$13.92	\$0.24	TN	\$2.66370	\$4.15039
vincristine	powder for injection (1mg)	\$4.08	eMIT	\$2.78	\$0.05	TN	\$0.53274	\$1.31408
vinorelbine	1mL vial (10mg)	\$6.23	eMIT	\$6.76	\$36.79	P		
vinorelbine	5mL vial (50mg)	\$23.41	eMIT	\$33.61	\$152.63	P		
zidovudine (ZDV or AZT)	20mL vial (200mg)	\$11.60	BNF		\$0.20	P	\$0.05046	\$0.67216

eMIT – price source was the electronic market information tool, available from <https://www.gov.uk/government/publications/drugs-and-pharmaceutical-electronic-market-information-emit>

BNF – price source was the British National Formulary, available from <https://bnf.nice.org.uk/>

TN – price source was the database of the Tamil Nadu Medical Services Corporation, available from http://www.tnmsc.com/tnmsc/new/user_pages/drugtender.php?drugcat=drug2017 and http://www.tnmsc.com/tnmsc/new/user_pages/drugtender.php?drugcat=sdg2017

P – price source was the MedGuide India database, available from <http://www.medguideindia.com/>

Prices in South Africa were collected from the South Africa Department of Health Master Procurement Catalogue. Available from <http://www.health.gov.za/index.php/component/phocadownload/category/196> (accessed May 12, 2017).

Exchange rates

Exchange rates used were 1 INR = 0.015 USD, 1 GBP = 1.3 USD, 1 ZAR = 0.075 USD.

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Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as “cost-effectiveness analysis”, and describe the interventions compared.	Page 1, lines 1-2
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	Page 2, lines 1-27
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study.	Page 4, lines 3-8
		Present the study question and its relevance for health policy or practice decisions.	Page 4, lines 24-29
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	Page 5, lines 3-38
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	Not applicable
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	Not applicable
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	Not applicable
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Not applicable, as this is a ‘snapshot’ price estimate and comparison to current prices (one time point: the present moment)
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	No discount rate used, as snapshot estimate
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Not applicable
Measurement of effectiveness	11a	<i>Single study-based estimates:</i> Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	Not applicable

Section/item	Item No	Recommendation	Reported on page No/ line No
	11b	<i>Synthesis-based estimates:</i> Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	Not applicable
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	Not applicable
Estimating resources and costs	13a	<i>Single study-based economic evaluation:</i> Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Not applicable
	13b	<i>Model-based economic evaluation:</i> Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Pages 5-8
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	Page 8, line 6
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	Not applicable
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	Not applicable
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	Page 5, lines 27-32 and page 6, lines 1-13.
Results			

Section/item	Item No	Recommendation	Reported on page No/ line No
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	Not applicable.
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Not applicable
Characterising uncertainty	20a	<i>Single study-based economic evaluation:</i> Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	Not applicable
	20b	<i>Model-based economic evaluation:</i> Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Not applicable
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	Not applicable
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	Pages 10-13
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Page 14, lines 3-4
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance	Page 14, lines 8-11

Section/item	Item No	Recommendation	Reported on page No/ line No
		with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	

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