

Estimated cost-based generic prices for molnupiravir for the treatment of COVID-19 infection

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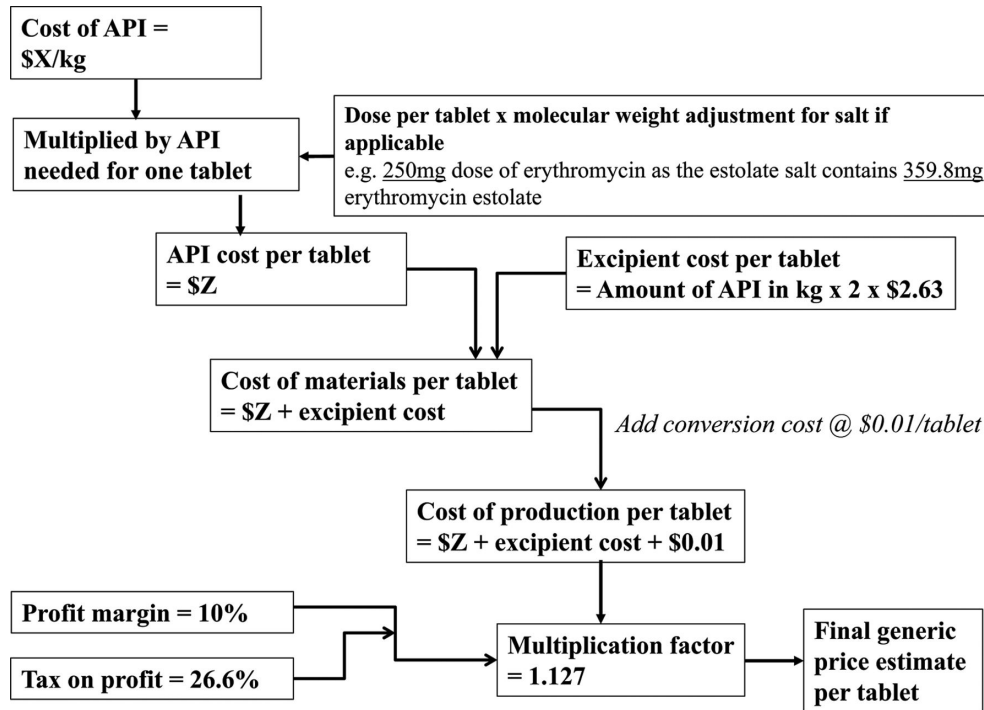
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Methodology

The method for calculating the cost of production follows the algorithm developed in an earlier analysis.¹

A figure outlining the estimation formula for a solid oral dosage form medicine is copied below.



In order to identify shipments of active pharmaceutical ingredient (API), a proprietary export/import database (Panjiva) was searched for the word 'molnupiravir' in the shipment description, for dates between 2016 and the most recent date available, including shipments 1) exported from India to any destination and 2) imported from any source by the United States, Mexico, Costa Rica, Panama, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, China, India, Indonesia, Pakistan, Sri Lanka, and the Philippines.

¹ Hill AM, Barber MJ, Gotham D. Estimated costs of production and potential prices for the WHO Essential Medicines List. *BMJ Global Health* 2018; **3**: e000571. <https://gh.bmj.com/content/bmjgh/3/1/e000571.full.pdf>

Results

After data cleaning,² twelve viable lines of data (i.e. individual shipments) were identified, listed below.

Export/Import	Shipment date	Item Quantity (KG)	Shipper	Shipment origin	Port of Unlading	Value of goods for whole shipment (USD)
Export	2021-07-31	1	Optimus Drugs Private Ltd.	India/Hyderabad	Dhaka	1432.02
Export	2021-07-29	5	Maithri Laboratories (P) Ltd.	India/Jinnaram	Istanbul	20000
Export	2021-07-14	10	Optimus Drugs Private Ltd.	India/Hyderabad	Cairo	14919.82
Export	2021-07-14	5	Optimus Drugs Private Ltd.	India/Hyderabad	Istanbul	4665.29
Export	2021-07-02	12	Optimus Drugs Private Ltd.	India/Hyderabad	Cairo	8905.5
Export	2021-07-02	5	Optimus Drugs Private Ltd.	India/Hyderabad	Cairo	9926.98
Export	2021-07-01	7	Optimus Drugs Private Ltd.	India/Hyderabad	Ho Chi Minh City	10127.81
Export	2021-06-30	2	Optimus Drugs Private Ltd.	India/Hyderabad	Dhaka	5927.11
Export	2021-06-23	2	Optimus Drugs Private Ltd.	India/Hyderabad		8033.22
Export	2021-06-21	4	Honour Lab Ltd.	India/Hyderabad	Istanbul	9898.79
Import	2021-07-06	20	Shanghai Agrotree Chemical Co., Ltd.	China	Luque (PY)	36309
Import	2021-05-27	10	Hengxin Pharma Co., Ltd.	China	Luque (PY)	49270

² See Appendix of Hill et al. 2018 for details on approach to data cleaning, available here: <https://gh.bmj.com/content/bmjgh/3/1/e000571/DC1/embed/inline-supplementary-material-1.pdf?download=true>

From these data, the weighted³ mean market price for molnupiravir active pharmaceutical ingredient (API) was US\$2,162/kg.

We assumed a treatment regimen of four 200 mg molnupiravir capsules twice daily for 5 days.

Using the weighted mean market price for molnupiravir with the costing algorithm described in the methodology, we estimate that the cost of production for molnupiravir capsules is US\$1.74 per unit, or US\$17.74 per 5-day regimen.

Adding an allowance for 10% profit margin and taxes in India, we arrive at an estimated sustainable generic price of US\$1.96 per capsule or US\$19.99 per 5-day regimen.

Cost of production – single 200 mg molnupiravir capsule	\$0.44
Cost of production – 5-day treatment course	\$17.74
Estimated sustainable generic price per treatment course (cost of production + 10% profit margin + allowance for 27% tax on profits)	\$19.99

An April 2021 analysis of the industrial synthesis of molnupiravir, by Ahlqvist et al at the Massachusetts Institute of Technology (MIT), independently estimated the cost of production for the active ingredient. Ahlqvist et al estimated that, starting from raw materials and using an optimized synthetic process, molnupiravir active ingredient would cost US\$427-799/kg to manufacture.⁴

Assuming Ahlqvist et al estimated for optimized production:

	With 75% solvent recycling	Without 75% solvent recycling
Cost of production – single 200 mg molnupiravir capsule	\$0.10	\$0.17
Cost of production – 5-day treatment course	\$3.86	\$6.84
Estimated sustainable generic price per treatment course (cost of production + 10% profit margin + allowance for 27% tax on profits)	\$4.35	\$7.70

³ Weighted by kilograms in each shipment.

⁴ See page 3 of supplementary information, Ahlqvist et al. "Progress Towards a Large-Scale Synthesis of Molnupiravir (MK-4482, EIDD 2801) from Cytidine".
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8153789/>

Conclusions

The API shipments captured in our search total 83 kg, sufficient for 10,375 patient treatments.⁵ Three companies appear to be exporting molnupiravir API: Optimus Drugs Private, Honour Lab, and Maithri Laboratories. Optimus Drugs Private advertises molnupiravir API on its website.⁶

The proprietor pharmaceutical company, Merck, announced on 27 April 2021 that they had entered into non-exclusive voluntary licensing agreements for molnupiravir with five Indian generics manufacturers (Cipla Limited, Dr. Reddy's Laboratories Limited, Emcure Pharmaceuticals Limited, Hetero Labs Limited, and Sun Pharmaceutical Industries Limited).

The US government has already ordered 1.7 million treatment courses, at about \$700/patient.⁷ This price is equal to about 35 times the estimated sustainable generic price using current market prices for the active ingredient (API) observed in our analysis. Assuming optimization of molnupiravir synthesis, and a resulting drop in API cost, the US price would be equal to about 161 times the estimated sustainable generic price.

Scenario	Cost (USD)
1.7 million treatment courses at \$700	\$1,190,000,000
1.7 million treatment courses at estimated sustainable generic price, current market API cost	\$33,978,763
1.7 million treatment courses at estimated sustainable generic price, API cost with optimised synthesis	\$7,394,454

⁵ Assuming a 5-day treatment course with 4*200mg twice a day, as above.

⁶ <https://optimuspharma.com/apis/>

⁷ <https://www.nytimes.com/live/2021/09/30/world/covid-delta-variant-vaccines#merck-antiviral-pill-covid>