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Estimating Worldwide Current Antibiotic Usage: Report of Task Force 1

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Estimates of antibiotic availability from a number of countries throughout the world were developed as an indicator of potential patterns of human antibiotic use. Data were organized by major classes of antibiotics and by some individual products and converted to units of weight and defined daily dosages per 1,000 population per day. Estimates were based either on sales or on production and trade data, including global production of penicillins, cephalosporins, tetracyclines, and erythromycins. The data obtained showed that antibiotic availability can vary widely among countries as well as from year to year in the same country.

The extraordinary therapeutic effects of antibiotics, the occurrence of resistance, and the considerable resources spent on antibiotics worldwide are compelling reasons for concern about adequate and appropriate use of these powerful agents. Antibiotics often account for 15%–30% of drug expenditures, the largest share of any therapeutic group of drugs. Along with vaccines, oral rehydration solutions, and contraceptives, antibiotics represent the vehicles with the most potential impact on preventable mortality in the developing world, and of these groups, antibiotics frequently are perceived as representative of the paradigm for therapeutic impact and hence are seen by both the public and professionals as good candidates for assessment.

The extensive literature on antibiotic use in Europe and the United States, particularly in hospitals, is testimony to the widespread concern about the appropriate use of these agents [1–12]. However, information on antibiotic use on a national level is scanty, and hospital use is a minority element in total drug use in much of the developing world. The types of data needed for an assessment of whether antibiotics are adequately and appropriately used are not widely available. Consequently, this task force report focuses on estimating the availability of antibiotics, basing these estimates on sales, production, and trade data. The study is limited to human medicinal uses of antibiotics; no consideration is given to the use of antibiotics in animal feeds or for other purposes.

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Supplemental data on antibiotic use in Chile (1983), Germany (1983), India (1973–1974), Japan (1978–1983), Korea (1983), Malaysia (1978), Mexico (1980), Nigeria (1983–1984), Norway (1973–1983), Panama (1981–1984), Philippines (1984), Spain (1983), Sweden (1972–1983), and the United States (1965–1981) are appendixes to this report and are available by request from the first address listed below.

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Estimates of availability can potentially be derived from a variety of sources within each country; these sources separate into two broad categories – production and trade data, and sales data. Production and trade data (reported in terms of raw materials or finished product) are estimates of the amounts of antibiotics that are available for distribution and eventual consumption at any point in time. They are based on domestic production figures and imports, minus exports. Sales data (reported as sales to stores or institutions that distribute antibiotics or as sales directly to the patient) show amounts actually purchased.

Conclusions based on either of these two sources of data are often divergent and are sometimes conflicting. In both cases, the critical question of actual consumption is bypassed since losses occurring in storage, transit, and as a result of noncompliance on the part of patients are not taken into account. For the present, availability of antibiotics on a national level remains the best proxy for antibiotic use.

We have attempted to examine antibiotic availability in countries that represent major regions of the world, different levels of economic development, and different types of economies. However, because of the difficulties in obtaining any data on antibiotic availability, the final selection of countries was determined largely by the availability of data.

Because of the nonuniformity of antibiotic classifications systems, the task force prepared a classification system (table 1). All data provided have been modified, when possible, to fit into this classification system.

The Data

Although on first inspection there appears to be a great deal of information on antibiotic production or sale, closer examination reveals that much of it is conjectural, anecdotal, or of questionable reliability. Moreover, much of the data are not publicly available – apparently for competitive reasons.

The data presented in this report are the result of an exhaustive search including a computer literature search on several major international data bases, including Frost and Sullivan Market Research Reports, HARFAX Industry Data Sources, and PTS/Forecasts; inquiries to the ministries of health of all World Health Organization (WHO) member countries; inquiries to the pharmaceutical manufacturers' associations of all countries belonging to the International Federation of Pharmaceutical Manufacturers' Associations; inquiries to many major pharmaceutical companies; and inquiries to several international organizations (including the United Nations Industrial Development Organization [UNIDO] and WHO).

Production and Distribution Channels

Tracing the flow of antibiotics from production and trade through the various distribution channels to final consumption (figure 1) shows that each data source measures a different flow and will therefore give a different estimate of availability.

Figure 1 presents a generalized framework that can be broadly applied, although each country has its own distinct channels and not all of the data sources illustrated are available in each country. In fact, in many countries it is extremely difficult at this time to make any reasonable estimate of the availability of antibiotics. Also, measurements at the same point in the distribution channel in different countries may give estimates that are not comparable because of differences in their systems of data collection.

The amounts of antibiotics available for distribution within each country are determined by the amounts produced and/or traded, information that may be recorded by official trade registers or by private manufacturers. A portion may be diverted from human use for nontherapeutic uses (i.e., growth promotion in animals) or for nonhuman therapeutic uses (i.e., agricultural uses). Nonhuman uses can account for a significant share of the market. In the United States, for example, 13% of the value of all antibiotic preparations was applied to veterinary uses (1982) [13]. Unfortunately, data on production and trade generally do not distinguish between human and nonhuman uses or between therapeutic and nontherapeutic uses.

Antibiotics destined for human use can be distributed to the patient through wholesalers, pharmacies, nursing homes, clinics, private hospitals, or government facilities. In countries where antibiotics can only be obtained by a prescription, distribution will be mediated by licensed practitioners, although, regardless of law, in many countries patients may purchase antibiotics directly through a pharmacy or retail outlet.

Sales to institutions that distribute antibiotics may be substantially different from sales to the patient. Data sources closer to final consumption will give potentially better estimates of human consumption

Table 1. System used in classifying antibiotics for antibiotic availability estimate sheet.

Major class	Illustrative drugs in class
Tetracyclines	Tetracycline
	Demeclocycline
	Doxycycline
	Methacycline
	Minocycline
	Oxytetracycline
	Chlortetracycline
Chloramphenicol	Chloramphenicol
	Thiamphenicol
Cephalosporins	
1st-generation	Cephaloridine
	Cephalothin
	Cephalexin
	Cephradine
	Cefaclor
	Cefadroxil
	Cephapirin
2nd-generation	Cefazolin
	Cefoxitin
	Cefuroxime
	Cefamandole
	Cefmetazole
3rd-generation	Cefoperazone
	Cefotaxime
	Cefsulodin
	Ceftazidime
	Ceftizoxime
Macrolides	Erythromycin
	Oleandomycin
	Tylosin
	Spiramycin
	Virginiamycin
Lincosamides	Lincomycin
	Clindamycin
Penicillins	
V, VK	Phenoxymethylpenicillin
	Phenoxymethylpenicillin potassium
G	Benzylpenicillin
	Benethamine penicillin
	Procaine penicillin
Broad-spectrum	Ampicillin
	Amoxicillin
	Pivampicillin
	Bacampicillin
	Hetacillin
	Carbenicillin
	Ticarcillin
	Apalcillin
	Azlocillin
	Mezlocillin
	Piperacillin
(Penicillins continued)	
Antistaphylococcal	Nafcillin
	Methicillin
	Oxacillin
	Cloxacillin
Streptomycin	Streptomycin
Aminoglycosides	Kanamycin
	Paromomycin
	Neomycin
	Gentamicin
	Tobramycin
	Ribostamycin
	Sisomicin
	Netilmicin
	Amikacin
	Dibekacin
Urinary antibacterial agents	Nalidixic acid
	Oxolinic acid
	Pipemidic acid
	Nitrofurantoin
	Methenamine
Sulfonamides	Sulfacytine
	Sulfadiazine
	Sulfamethizole
	Sulfamethoxazole
	Sulfapyridine
	Sulfasalazine
	Sulfasoxazole
	Trisulfapyrimidines
Trimethoprim	Trimethoprim
Antituberculosis agents	*p*-Aminosalicylic acid
	Capreomycin
	Cycloserine
	Ethambutol
	Ethionamide
	Isoniazid
	Pyrazinamide
	Rifampin
Other antibiotics	Vancomycin
	Ristocetin
	Bacitracin
	Colistin
	Polymyxin B
	Spectinomycin
	Novobiocin
	Metronidazole

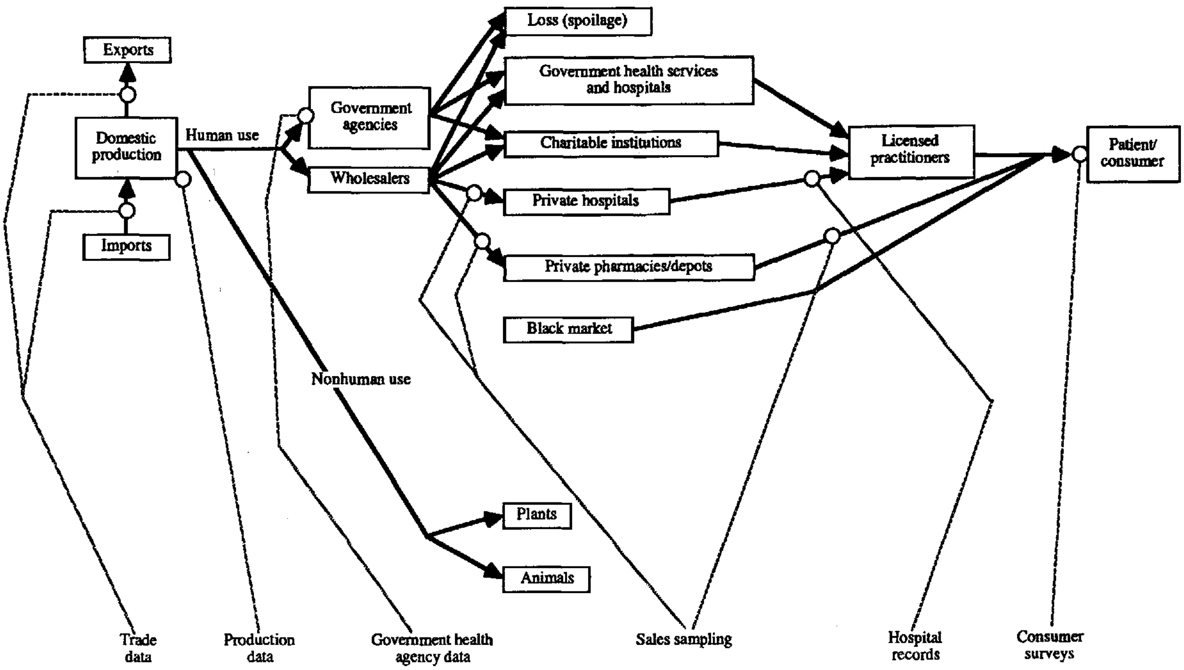

Figure 1. Illustrative distribution channels for antibiotics. The circles indicate the distribution channels at which samples were obtained.

because there are fewer possibilities for diversion from domestic human use. However, the present lack of comprehensive data on human use of antibiotics may lead to an underestimate of actual use. Estimates based on production/trade, on the other hand, will generally encompass the entire market but may lead to an overestimate of human use because of diversion to nonhuman uses.

Because of the differences between production/trade data and sales data, this report will treat these two types of data separately. Where possible, the two estimates will be compared.

Production/Trade Data

Global Production of Antibiotics

Table 2 presents estimates of the global production of various antibiotics. Penicillins constitute the largest class, followed by tetracyclines. Lowe states that "Today [1982] there is sufficient penicillin fermentation and production capacity worldwide to provide every individual on this planet with sufficient penicillin for one therapeutic treatment each year" [14].

Table 2. Global availability of antibiotics by class based on production figures.

Drug/group	Quantity (1,000 tons)	Year	Potential consumption (g/person/year)*
Penicillins	14.8	1978	3.51
Penicillins	17.0	1980	3.85
β-Penicillin	7.6	1975	
β-Penicillin	10.0	1979	2.31
Fermented penicillins	5.5	1979	1.27
Semisynthetic penicillins	5.32	1979	1.23
Ampicillin	2.6	1977	
Amoxicillin	0.595	1977	
Cephalosporins	0.9	1979	0.21
Injectable	0.475	1979	0.11
Oral	0.69	1979	0.16
Cephalosporins	1.2	1980	0.27
Tetracyclines	5.0	1980	1.13
Erythromycins	0.8	1980	0.18

NOTE. Data are from [5–17].

* These are not actual consumption figures but represent amounts that might be consumed if all of the production capacity were used for that product and if all antibiotics that were produced were consumed. These figures were calculated by dividing quantities produced annually (in grams) by global population.

Table 3. Antibiotic availability in selected countries based on production and trade data.

Antibiotic classification	Mozambique 1982	Korea 1983	Philippines 1984	India 1982–83	Chile 1983	Nigeria 1983–84*	Ghana 1984	Costa Rica 1984
	Availability (g/1,000 population/day in indicated year)							
Tetracyclines	1.16	13.50	2.86	1.68	1.93	2.45	2.28	0.68
Chloramphenicol	0.10	7.84	0.76	0.12	1.85	NA	1.25	0.24
Cephalosporins	0.0006	2.65	NA	NA	0.18	0.02	0.10	2.32
Macrolides (erythromycin)	0.11	3.68	0.66	0.12	1.13	NA	0	1.18
Lincosamides	0	0.61	NA	NA	0.06	NA	0.03	0.04
Penicillins						1.67	4.66	
Narrow-spectrum	0.12†	1.95	2.47	0.004 MU‡	1.55	NA	2.78	NA
Broad-spectrum	0.66	20.92	2.31	0.38§	NA	NA	1.84	4.33
Antistaphylococcal	0	NA	NA	NA	1.16	NA	0.04	1.6
Streptomycin	0.03	1.10	0.54	0.09	NA	0.33	0.39	0.03
Aminoglycosides	0.03	3.03	0.03	NA	NA	0.002	0	0.04
Urinary antibacterial agents	0.08	0.54	NA	NA	NA	NA	0.32	0.63
Sulfonamides	NA	7.04	NA	NA	3.01	NA	0.15	0.03
Trimethoprim-sulfamethoxazole	0.81‖	NA	NA	NA	3.26	NA	NA#	3.0**
Antituberculosis agents	0.14	13.8	NA	NA	NA	NA	0.04	0.276

NOTE. Data are from the following sources: Mozambique, Ministry of Health, Pharmaceutical Division; Korea, personal communication; Philippines, Government of Philippines, Food and Drug Administration; India, Department of Chemicals and Fertilizers; Chile, personal communication; Nigeria, personal communication on import statistics; Ghana, Ministry of Health; and Costa Rica, Caja Costarricense de Seguro Social. NA = not available.

* Average of 1983 and 1984.

† In addition, 0.001 international units were available.

‡ MU = million units (for India narrow-spectrum penicillins only).

§ Includes only ampicillin and amoxicillin.

‖ Most of the trimethoprim-sulfamethoxazole (TMP-SMZ or cotrimoxazole) composed of 400 mg of SMZ and 80 mg of TMP.

Although there are no data on TMP-SMZ listed, Ghana does import TMP (0.13 g/1,000 population/day) and SMZ (0.04 g/1,000 population/day).

** Minimum figure is given; some data are not included.

Table 4. Antibiotics imported into Mozambique, 1980–1982.

Major classes of antibiotics	1980	1981	1982
	Imports (in grams) by government in indicated year		
Tetracyclines	587,209	3,521,800	5,469,850
Chloramphenicol	205,125	484,825	452,425
Cephalosporins (total)	1,625	1,150	3,150
Macrolides (erythromycin)	162,700	226,478	496,250
Penicillins (total)			
V, VK	262,500	275,000	576,750
G	1×10^7 MU*	1.4×10^7 MU	4.5×10^6 MU
Broad-spectrum	2,810,750	2,692,800	3,087,900
Antistaphylococcal	4,250	22,125	38,675
Streptomycin	4,000	300,000	150,000
Aminoglycosides (kanamycin, neomycin, and gentamicin)	91,335	17,838	152,099
Urinary antibacterial agents (nalidixic acid only)	358,904	500,480	364,960
Sulfonamides			
Trimethoprim-sulfamethoxazole	1,843,680	2,261,760	3,831,552
Antituberculosis agents	35,150	874,850	668,008

NOTE. Data were obtained from the Government of Mozambique (Ministry of Health, Pharmaceutical Division). In Mozambique there is no domestic manufacturing of antibiotics.

* MU = million units.

International Comparison of Availability, Based on Production and Trade Data

Table 3 presents availability estimates for Mozambique, Korea, the Philippines, India, Chile, Nigeria, Ghana, and Costa Rica in recent years. The data were obtained from drug regulatory agencies, pharmaceutical services of ministries of health, and other government ministries (departments of commerce or customs and excise, pharmaceutical manufacturers, or pharmaceutical manufacturers' organizations may have this information, although it is not always publicly available). Since Mozambique and Chile have no domestic drug manufacturers, information for these countries is based exclusively on data about imports. Data for Korea, the Philippines, and India rely on domestic manufacturers and trade. All data have been converted to grams/1,000 population per day to facilitate comparisons between countries, except for data on penicillins, which may be listed as million units/1,000 population per day.

The data suggest substantial differences among countries. Most apparent is the much greater availability of most antibiotics in Korea than in the other countries listed. Tetracyclines are the commonest antibiotics in Mozambique, the Philippines, and India, whereas the broad-spectrum penicillins dominate the market in Korea and trimethoprim-sulfamethoxazole dominates the market in Chile.

These findings must be interpreted with great caution. Since data were collected from different sources in each country, the reliability of the estimates may vary substantially. The extent of nonhuman antibiotic consumption remains unclear, and drugs produced or imported in one year may not be consumed during that year because of inventory changes or production, processing, and distribution losses—including spoilage. These amounts may be nontrivial, as will be shown in the case of Mozambique.

Country Study—Mozambique, 1980–1982

Striking annual fluctuations were noted in antibiotic imports into Mozambique in 1980–1982 (table 4). For example, the amount of streptomycin imported increased from 4,000 g in 1980 to 300,000 g in 1981, dropping to one-half this figure in 1982. It is probably safe to assume that consumption did not change in parallel but that inventory-management decisions played a significant role. The multiplicity of factors potentially responsible for such large yearly changes underscores the complexity of assessing a country's situation from production and import data.

Despite these large fluctuations, certain patterns of use may be inferred. Tetracyclines are the most important class (by weight), followed by broad-spectrum penicillins and trimethoprim-sulfamethoxazole, which are used in roughly equal amounts. Cephalosporins show the least use.

Sensitivity Analysis

It is instructive to illustrate the impact of error in the values in table 3, with use of the Indian estimate of 0.12 g/1,000 population per day for chloramphenicol.

Even if errors (due to miscalculation, storage, or distribution and diversion to nonhuman and nontherapeutic uses) were of the order of magnitude of 100%, India at 0.24 g/1,000 population per day would still have ~1/3, 1/8, and 1/33 the availability of chloramphenicol of the Philippines, Chile, and Korea, respectively. Such large differences suggest that the data have value as indicators of orders of magnitude.

The utility of production-type data would be greatly improved if the data were routinely separated into those on products for human, nonhuman, and nontherapeutic destinations, respectively, and if data on raw materials were separated from those on finished products.

Sales Data

This section presents availability estimates derived from two types of sales data: on sales to agencies or stores that distribute antibiotics and on sales by pharmacies to health practitioners or patients. Since these two types of sales data measure different quantities in the process, they will be presented and compared separately.

Again, sales are but an indicator of actual consumption; patient noncompliance, storage of drugs at home, spoilage, and differences in dispensing are examples of factors that contribute to the disparity between sales and actual consumption.

Percentage of Drug Utilization Represented by Antibiotics

For the 18 countries listed in table 5, antibiotics accounted for between 3% and 25% of all prescriptions in 1983, holding a larger share of the market in Latin American than in European countries. The more developed countries generally have a lower percentage of antibiotic use (as measured by expenditure) than do the less developed countries. The Philippines, where >25% of all prescriptions are for antibiotics, has the highest percentage usage of antibiotics of those countries listed.

It is of interest to note that Japan has the highest market share (by value) for antibiotics and has one of the lowest shares of antibiotic prescriptions. This difference may be explained by a relatively high use of expensive antibiotics (probably cephalosporins).

The uncertainties of the data notwithstanding, it is clear that antibiotics represent substantial fractions of the total drug budgets of many countries and often constitute the single largest group of drugs purchased in developing countries.

Table 5. Antibiotic sales as percentage of pharmaceutical market: 1977 and 1983.

Country	Percentage of market value 1977	Percentage of market value 1983	Percentage of total prescriptions, 1983
Argentina	15.22	12.2	15.2
Brazil	11.20	12.1	12.11
Mexico	20.60	18.3	18.68
Peru	19.40	16.3	NA
Uruguay	19.60	NA	NA
Venezuela	29.00	12.8	12.57
West Germany	3.0*	5.9	2.82
France	10.4*	8.1	5.3
Italy	13.6*	12.7	7.13
United Kingdom	8.4*	9.2	11.98
Spain	NA	13.9	10.84
South Africa	NA	10.0	19.49
Japan	NA	21.1	7.6
Philippines	NA	19.9	25.1
Australia	NA	8.6	NA
Sweden	NA	7.9	NA
United States	11.3	11.6	13.00
Canada	NA	7.1	NA

NOTE. Data are from [18]. No information is available on the methodology used for compiling these data. It is not clear whether these data cover the entire market in each country or cover just those antibiotics distributed through private, nonhospital pharmacies and nongovernment agencies. NA = data not available.

* These figures are for 1976.

Estimates of Individual Antibiotic Availability Based on Sales in the Nonpublic Sector

Table 6 presents availability estimates that are based on sales in the nonpublic sector of individual antibiotics in 15 countries. Comparisons between antibiotics are facilitated by the presentation of availability as defined daily doses (DDDs)/1,000 population per day. A DDD is the average maintenance dose for the main indication of a particular drug. Use of the DDD enables a comparison between products as well as between countries of a population's exposure to drugs. DDDs/1,000 population per day can be interpreted as the proportion of the population that may receive treatment with a particular drug.

The DDD is not a recommended dose, but rather a technical unit of comparison. DDDs are based on usage in Norway, where the concept was first developed, and are given as the amount of active substance whenever possible (DDDs are usually the same for all dosage forms of a preparation). The data have been converted to DDDs/1,000 population per day as follows: [amount of antibiotic (g) × 1,000]/DDD (g) × 365 × population.

Even though the DDD is a useful unit of comparison, data utilizing it should be interpreted with some caution. Since DDDs are based on usage in Norway, some DDDs may be inappropriately high or low for other countries. Also, many antibiotics that are not used in Norway have not been assigned DDDs. While there have been supplements to the Norwegian DDDs, these antibiotics may not be directly comparable to those assigned DDDs in Norway. Additional problems arise when dosages vary widely (as is the case for many antibiotics), when one drug is used for more than one major indication, or when drugs are used in combination with other drugs for the same disease.

Another problem is that the DDD does not take into account pediatric uses. Since children's doses are substantially lower than the established DDDs, this omission will lead to an underestimation of population exposures. In countries where children account for a significant proportion of the population, as in most developing countries, the error introduced could be significant.

The data are based on estimates of retail sales of individual antibiotics in the United States, Japan, Mexico, France, Spain, United Kingdom, Italy, Brazil, Argentina, Canada, Germany, Australia, Venezuela, Sweden, and South Africa during 1983.

Table 6. Antibiotic use in 15 countries, 1983.

Country	Penicillin G†	Carbenicillin (12)	Amoxicillin (1)	Ampicillin (2)	Sum of broad-spectrum penicillins‡	Cefaclor (2)	Cefalexin (2)	Tetracycline (1)	Oxytetracycline (1)	Doxycycline (0.1)	Sum of tetracyclines§	Erythromycin (1)	Streptomycin (1)	Gentamicin (0.24)	Chloramphenicol (3)	Sulfamethoxazole (2)	Trimethoprim (0.4)
	DDD/1,000 population/day*																
United States	0.22	0.00008	2.24	1.14	3.38	0.16	0.55	2.51	0.05	1.12	3.68	4.09	0.001	0.005	0.004	1.14	1.10
Canada	0.75	0.00005	3.04	0.70	3.74	0.06	0.26	2.51	0.0008	0.51	3.02	2.36	. . .	0.01	0.004	1.45	1.50
Australia	0.20	0.0002	4.76	0.38	5.14	0.08	0.01	3.37	0.03	2.88	6.28	2.81	0.04	0.009	0.006	2.60	2.61
Sweden	0.50	0.0007	0.63	0.10	0.73	0.08	0.12	0.16	0.15	2.50	2.81	2.08	. . .	0.02	0.02	0.69	1.24
France	0.33	. . .	4.97	0.80	5.77	0.11	0.21	1.56	0.39	2.72	4.67	2.28	0.009	0.15	0.009	1.02	1.21
Germany	0.13	. . .	0.52	0.20	0.72	0.08	0.04	0.83	0.55	2.22	3.6	0.70	0.002	0.02	0.01	1.14	1.18
United Kingdom	0.10	0.0001	2.59	0.78	3.37	0.06	0.43	0.67	1.42	0.43	2.52	1.76	0.007	0.01	0.006	1.12	1.42
Italy	0.28	0.0005	3.16	0.72	3.88	0.11	0.61	0.70	0.06	0.33	1.09	1.02	0.05	0.11	0.04	2.20	2.36
Spain	1.14	0.0004	10.34	2.05	12.39	0.02	0.21	2.01	0.28	2.02	4.31	1.50	0.65	0.22	0.31	3.94	4.01
Japan	0.11	0.02	2.25	0.65	2.92	0.44	2.49	0.33	0.05	1.41	1.79	0.91	0.10	0.07	0.04	0.36	0.13
Mexico	1.27	0.0002	0.48	1.66	2.14	0.009	0.09	0.63	0.80	0.14	1.57	1.27	0.07	0.15	0.18	0.42	0.48
Brazil	0.38	0.0003	0.30	0.41	0.71	0.006	0.05	0.48	0.29	0.26	1.03	0.51	0.02	0.04	0.12	0.79	0.83
Argentina	0.86	0.0006	2.28	1.35	3.63	0.009	0.27	0.75	0.29	0.19	1.23	1.09	0.13	0.22	0.40	1.22	1.28
Venezuela	0.49	0.0003	0.38	0.80	1.18	0.02	0.17	0.39	0.33	0.24	0.96	1.30	0.007	0.21	0.03	0.41	0.41
South Africa	0.018	0.000009	0.42	0.13	0.55	0.02	0.04	0.27	0.22	0.08	0.57	0.32	0.04	0.004	0.004	0.28	0.29

NOTE. Data are based on estimates of sales in the nonpublic sector. These estimates do not include hospital use or sales through government outlets.

* DDD = defined daily dose. See text for definition. Numbers in parentheses are DDD values (in grams) for antibiotic.

† Figures for penicillin G are not given in terms of DDD/1,000 population/day but as 10^6 international units/1,000 population/day. DDDs could not be calculated because of wide differences in DDDs among different forms of penicillin G.

‡ Includes the sum of the following broad-spectrum penicillins: carbenicillin, amoxicillin, and ampicillin.

§ Includes the sum of the following tetracyclines: tetracycline, oxytetracycline, and doxycycline.

Table 7. Sales of antibiotics by class in seven countries.

	Sale (g/1,000 population/day) in indicated country and year						
Antibiotic(s)	Japan 1982	India 1983	Spain 1984	Panama 1984	Mexico 1983	Norway* 1983	Sweden* 1983
Tetracyclines	0.53	0.91	1.45	0.42	1.36	3.6	3.0
Chloramphenicol	1.02†	0.34	0.11	0.05	0.93	<0.02	<0.02
Cephalosporins	10.44	0.02	1.71	0.39	0.26	0.14	0.3
Macrolides	0.91	0.12		1.11	2.29	0.98	1.6
Lincosamides				0.10‡	0.44		
Macrolides and lincosamides	2.13		1.71				
Penicillins	6.09			7.11‡			
V, VK		0.80		0.75‡			
G				2.77‡			
Narrow-spectrum			0.75		2.11		
Broad-spectrum		0.36	12.91	3.29‡	4.04	0.88	1.7
Antistaphylococcal				0.31	0.46		0.8
Streptomycin	0.10			0.11	0.29		
Aminoglycosides (gentamicin, kanamycin)	0.28	0.01	0.08	0.08	0.32		
Urinary antibacterial agents					0.64		
Sulfonamides					1.60		
Trimethoprim				0.13	0.11		
Trimethoprim-sulfamethoxazole		0.51	5.32				
Antituberculosis agents					0.09		
Other antibiotics					0.06		
Rifampin			0.18	1.37			

NOTE. Data are from the following sources: Japan, private-sector sales audit; India, Operations Research Group, Baroda (covers ~70% of the total market); Spain, sources within the National Institute of Health (Centro Especial "Ramon y Cajal"); Panama, Social Security Institute (covers ~70% of total consumption); Mexico, a combination of a private-sector sales audit and sales from two federal social security services (ISSTE and IMSS); Norway, Norsk Medisinaldepot; and Sweden, Swedish Pharmaceutical Data.

* Defined daily doses (DDDs)/population/day. See text for definition.

† Includes thiamphenicol.

‡ Data are for 1983.

These data include all sales, with or without prescription, through pharmacies and drugstores. Because these estimates do not include hospital use or sales through government outlets (and these amounts vary in different countries), the data are not directly comparable. However, the data do enable an estimation of use in the private nonhospital sector in each country. Also, there may be differences in data collection systems and reliability among countries.

The following points emerge from table 6: tetracyclines are widely used in developed countries; antibiotic consumption is generally greater in developed countries than in developing countries; there are differences in the relative use of ampicillin and amoxicillin, the developing countries generally having a higher relative use of ampicillin; Spain has the highest use of trimethoprim-sulfamethoxazole and of the broad-spectrum penicillins; Japan has the highest use of cephalosporins; use of carbenicillin is negligible in all countries except for Japan (0.02 DDDs/1,000 population per day in Japan; <0.0007 DDDs/1,000 population per day everywhere else); use of streptomycin is much higher in Spain and Argentina than elsewhere; Australia has the highest use of doxycycline and tetracyclines; and the use of erythromycin is highest in the United States. These observations suggest many useful lines for further investigation.

Sales Data by Major Classes

Table 7 compares the availability of antibiotics in seven countries. These data differ from those in table 6 in three respects. First, table 7 presents data by classes, not by individual antibiotics. Second, different countries are examined. Third, the sources of information are different. Whereas all of the data in table 6 were derived from the same source, the sources of the data in table 7 vary from one country to another.

Because of the different sources of the data in table 6 and table 7, special precautions must be taken in comparing the data across countries. Notably, different types of sales data, hence different segments of the market, are recorded in each country. The reliability of the data may vary from one country to another. Different time periods are compared in some countries. As in earlier tables, results are sensitive to the population base used. The calculations assume an even consumption of antibiotics across the entire population, although this is unlikely.

Keeping in mind the limitations of the data, the task force suggests the following conclusions: Japan has a much higher consumption of cephalosporins than do the other countries and also is the only country where cephalosporins are the most widely sold antibiotics; Spain has a much higher consumption of broad-spectrum penicillins than do the other countries; Norway and Sweden have much higher use of tetracyclines than do the other countries listed; Mexico and Japan have the highest use of chloramphenicols (the value listed for Japan includes thiamphenicol, which is used in much greater amounts than chloramphenicol in Japan); there are substantial differences in the patterns of use between countries as geographically and economically similar as Norway and Sweden (for example, Norway has higher consumption of macrolides, broad-spectrum penicillins, and tetracyclines); Spain has a relatively high use of cephalosporins (much lower than Japan yet substantially higher than any of the other countries listed); broad-spectrum penicillins are the most widely used antibiotic class in Spain, Panama, and Mexico, while tetracyclines are the most widely used in India, Norway, and Sweden and cephalosporins are the most widely used in Japan; India is the only country listed where the sales of narrow-spectrum penicillins (especially penicillin V, VK) are greater than the sales of broad-spectrum penicillins.

Conclusions

Task Force 1 was charged with providing a factual baseline measure of antibiotic use by a sample of countries around the world. Data currently accessible to the task force can, in general, only suggest estimates of availability, not of use. The many caveats and weaknesses of the data notwithstanding, the following important observations can be made.

There are large differences in the pattern of antibiotic utilization among countries. However, the absence of data on usage that is linked to patient profile, diagnosis, duration and dosage of therapy, emergence of resistant strains, drug prices, and consumers' access to drugs precludes any definitive evaluation of the effectiveness of antibiotic use in these countries. There may be as much underuse as overuse. In addition, aggregate national statistics may disguise wide disparities between the availability and use of antibiotics by the rural and periurban poor and that for the more affluent urban dwellers who have better access to health services.

Figure 2 illustrates the many factors that affect the level of antibiotic consumption in a country: population size, demographic structure, income levels and distribution, nutritional status, and occupational structure all affect a country's pattern of morbidity. The number of cases seen by health care personnel, in turn, is a function of this morbidity pattern coupled with the availability and use of health care facilities. Health care personnel comprise the critical link between the above-mentioned factors and the volume and mix of antibiotics prescribed. Finally, consumption is affected by the availability, marketing, and price of the antibiotics prescribed and the patient's compliance with the recommended regimen.

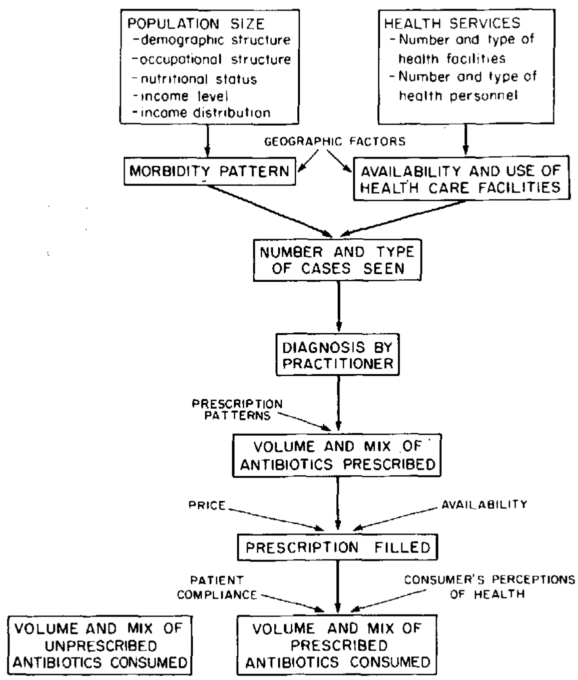

Figure 2. Factors affecting antibiotic consumption. Data are from [19].

Given the central role played by the prescribers, it is worth examining the factors that affect their choice of antibiotics. They are (*1*) the practitioner's knowledge about antibiotics, especially concerning indications and adverse reactions—the level of information of practitioners is largely a function of the level of their education, subsequent training, and the promotional activities of drug companies; (*2*) the availability of antibiotics, as affected by a country's drug regulations, trade restrictions, distribution networks, and local pharmaceutical industry; and (*3*) the price of antibiotics relative to income patterns of health expenditure and alternative treatments.

In countries where antibiotics are available over the counter, emphasis is shifted from health care personnel to the consumer, with the same factors affecting the consumer's selection of an antibiotic as affect the practitioner's.

The ideal type of data would permit a comparison of usage or, secondarily, of the prescribing habits of doctors from one country to another. However, this is only feasible when all other factors are held constant, notably, e.g., morbidity patterns, nutritional status, and occupational structure. The only countries where these factors come close to being held constant are Norway and Sweden.

While clear divisions of interest between the public, the pharmaceutical industry, and the health professions are readily made manifest by issues surrounding antibiotic use worldwide, there are several points where the common interest would be served by a more systematic collection and presentation of information on antibiotic availability.

Much of the data are noncompetitive. In the aggregate, data on the amount of the major classes of antibiotics available by country have little demonstrable competitive value and hence should not be restricted by industry. It is useful to highlight major potential gaps in availability of important antibiotics, as well as excesses, both of which appear to exist.

The current situation of public lack of awareness of and information on antibiotic issues distorts perceptions. Disagreements over partial, inadequate, and often erroneous information can waste the time and resources of all concerned and produce no useful result. Important dialogue between the public, producer, and professional communities is made more difficult when conjecture rather than fact is the substrate. The major effect is to amplify, and probably to distort, differences in essential interests.

The problem of obtaining reliable data is relatively easy to solve, and the information obtained would be a useful vehicle for the creation of a more constructive atmosphere. Useful, nonsensitive data can be obtained and used by all, and the real issues, e.g., information and education and the topics of other task forces, are more interesting and more appropriate subjects on which to focus attention.

Recommendations

The scope of this report has been limited by both the quality and quantity of data that are currently available on antibiotic use at the national level. Although many countries currently collect national data on antibiotic use, the lack of standardized data-collection systems makes comparisons difficult. Given the potential applications of such data, it would be invaluable to have uniform data-collection systems at the national level around the world. Two possible ways of achieving this are (*1*) by instituting a standard index for measuring drug use in each country, a concept analogous to the measurement of gross national product; this standard could be established by using the same system of drug classification, the same unit of measurement (e.g., DDDs/1,000 population per day or grams/1,000 population per day), and the same point in the distribution channel in each country; (*2*) by obtaining access to data of this type that are currently collected by private companies (i.e., International Medical Statistics) but are not made publicly available.

Quality data of this type would prove useful in monitoring total antibiotic use and in highlighting areas where use appears to be too high or too low. Having such a data base available could provide the impetus for promoting more effective use of antibiotics in countries throughout the world.

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