How to Measure Antimicrobial Consumption

Dominique L. Monnet
National Center for Antimicrobials and Infection Control, Statens Serum Institut, Copenhagen, Denmark
Fluoroquinolone consumption

- Nordic countries, 1990 (country): 0.5 DDD/1,000 inhabitant/day
- NL, 1990 (20 hospitals): 0.75 DDD/100 bed-days (extr. : 0.03-2.11)
- D, 1990 (21 hospitals): 2.14 DDD/100 bed-days (extr. : 0.70-5.96)
- CH, 1990 (11 hospitals): approx. 0.3 CHF/day
- USA, 1992 (1 hospital): 3.7 g (ciprofloxacin)/100 patient-days
- E, 1993 (country): 1.14 DDD/1,000 inhabitants (per day?)
- NL, 1994 (primary health care): 0.5 DDD/1000 persons/day
- NL, 1995 (1 hospital): 3.2 DDD/100 bed-days
- DK, 1995 (primary health care): 2%, i.e. 472,000 DDD
- DK, 1995 (hospital sector): 4%, i.e. approx. 89,000 DDD
- CDN, 1996 (country): 1,659,000 prescriptions
- F, 1997 (1 intensive care unit) : 212 local daily doses/year
- SK, 1997 (country) : approx. 370 packages
- DK, 1997 (primary health care) : 80.1 DDD/1,000 inhabitants x year
- DK, 1997 (hospital sector) : 1.4 DDD/100 bed-days
Denominators (1)

**Patient-days** (per 100 or 1,000 patient-days)
- i.e., occupied bed-days
- for antimicrobial consumption in hospitals
- theoretically:
  
  \[
  \text{day of admission} + \text{day of discharge} = 1 \text{ single day}
  \]

- in practice: administrative bed-days
- approximated by:
  \[
  \text{no. beds} \times \text{occupancy} \times \text{no. days (during period)}
  \]
**Denominators (2)**

- **Inhabitant-days** (per 1,000 inhabitant-days)
  - for antimicrobial consumption in primary health care
  - should NOT be used for consumption in hospitals

- **Admissions or discharges**
  - for antimicrobial consumption in hospitals
  - more stable
  - rarely used, except for calculating % patients exposed to antimicrobials
Calculating the Denominator: Examples

- FOR HOSPITAL A, YEAR 2001: 600 BEDS, OCCUPANCY INDEX = 0.85
  No. patient-days = 600 beds x 0.85 x 365 days

- FOR HOSPITAL B, JUNE 2002: 450 BEDS, OCCUP. INDEX = 79.5%
  No. patient-days = 450 beds x 0.795 x 30 days

- FOR ICU C, 1st TRIMESTER 2002: 8 BEDS, OCCUPANCY INDEX = 0.89
  No. patient-days = 8 beds x 0.89 x (31+28+31) days

- FOR REGION D, YEAR 2001: 1.67 MILLION INHABITANTS
  No. inhabitant-days = 1,670,000 inhabitants x 365 days
Sources of Numerator Data

- **Collective level**
  - Pharmaceutical industry sales (country/region)
  - Pharmacy purchases (hospital)
  - Pharmacy issues (unit/ward)

- **Patient level**
  - Prescriptions (prescribing physician/patient)
  - Chart review (patient)
  - National registers, e.g. Denmark (patient)
Numerators Available at Collective or Patient Level

- Measure ecological pressure
- Costs
- Units (packages, vials) ordered/distributed
- Grams/kilograms or I.U.
- Defined Daily Doses (DDD)
- Prescribed Daily Doses (PDD)
- "Pseudo-DDDs"
## Example of Pharmacy Report (1)

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Value</th>
<th>Volume Issued</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>001589</td>
<td>DOXYCYCLINE 100mg CAP 10 (When z/s 8's)</td>
<td>1</td>
<td>1</td>
<td>2000</td>
</tr>
<tr>
<td>074144</td>
<td>MINOCYCLINE 50mg TAB 84</td>
<td>281</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>074489</td>
<td>DEMECYCLOLINE 150mg CAP 100 (Disc)</td>
<td>-3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>089419</td>
<td>TETRACYCLINE 250mg TAB 20 (Disc)</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>090611</td>
<td>DOXYCYCLINE 100mg DISP TAB 8</td>
<td>154</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>100625</td>
<td>DOXYCYCLINE 50mg CAP 28</td>
<td>325</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>109754</td>
<td>MINOCYCLINE 100mg M/R CAP 56</td>
<td>26</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>119792</td>
<td>DOXYCYCLINE 100mg CAP 14 (OPD)</td>
<td>573</td>
<td>395</td>
<td></td>
</tr>
<tr>
<td>120197</td>
<td>TETRACYCLINE 250mg TAB 500</td>
<td>20</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>126624</td>
<td>TETRACYCLINE 250mg TAB / CAP 28</td>
<td>68</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>126926</td>
<td>DEMECYCLOLINE 150mg CAP 28</td>
<td>222</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>127353</td>
<td>DOXYCYCLINE 100mg CAP 8</td>
<td>1799</td>
<td>464</td>
<td></td>
</tr>
<tr>
<td>127752</td>
<td>DOXYCYCLINE 100mg DISP TAB 8 (OPD)</td>
<td>246</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>129828</td>
<td>OXYTETRACYCLINE 250mg TAB 28</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Sum:</strong></td>
<td></td>
<td><strong>3,716</strong></td>
<td><strong>1,105</strong></td>
<td><strong>2000</strong></td>
</tr>
</tbody>
</table>

## Example of Pharmacy Report (2)

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Value</th>
<th>Volume Issued</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>004979</td>
<td>AMOXICILLIN 125mg S/F SUSP 100ml</td>
<td>46</td>
<td>62</td>
<td>2000</td>
</tr>
<tr>
<td>004987</td>
<td>AMOXICILLIN 250mg S/F SUSP 100ml</td>
<td>355</td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>005002</td>
<td>AMOXICILLIN 250mg VIAL 10</td>
<td>41</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>005010</td>
<td>AMOXICILLIN 500mg VIAL 10</td>
<td>1,935</td>
<td>337</td>
<td></td>
</tr>
<tr>
<td>009105</td>
<td>PHENOXYMETHYLPPENN 125mg SYR 100ml</td>
<td>174</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>013358</td>
<td>FLUCLOXACILLIN 250mg VIAL 10</td>
<td>279</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>013366</td>
<td>FLUCLOXACILLIN 500mg VIAL 10</td>
<td>6,444</td>
<td>1,189</td>
<td></td>
</tr>
<tr>
<td>013374</td>
<td>FLUCLOXACILLIN 125mg SYR 100ml</td>
<td>298</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>021539</td>
<td>AMPICILLIN 500mg VIAL x 10 (RACH/SH/0H)</td>
<td>257</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>048100</td>
<td>AMOXICILLIN SACH 3G x 2</td>
<td>210</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>053252</td>
<td>PHENOXYMETHYLPPENICILLIN 250mg SYR 100ml</td>
<td>456</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td>059803</td>
<td>PIPERACILLIN 2G VIAL x 1</td>
<td>-30</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td>061484</td>
<td>PIPERACILLIN 1G VIAL x 1</td>
<td>-6</td>
<td>-2</td>
<td></td>
</tr>
</tbody>
</table>
Distribution into Classes of Antimicrobials

- Anatomical Therapeutical Chemical (ATC) Classification (WHO Collaborating Centre for Drug Statistics Methodology)

- This classification does not provide sub-grouping for:
  - Cephalosporins (all generations are in the same group)
  - Extended spectrum beta-lactams (e.g. amoxicillin and piperacillin are in the same group)
  - Combinations of penicillins and beta-lactamase inhibitors (e.g. amoxicillin-clavulanate and piperacillin-tazobactam are in the same group)
Numerators That Should NOT Be Used to Measure Antimicrobial Pressure

- Costs (US$, EURO)
  - easily available
  - but depend on price negociations

- Units (packages, vials) ordered/distributed
  - depend on package size

- Grams/kilograms or I.U.
  - give a different ”weight” to antimicrobials that have a different daily dosage
Defined Daily Doses (DDDs)

- Assigned by the WHO Collaborating Centre for Drug Statistics Methodology, Oslo (Norway)
- DDD = average maintenance dose (main indication, adult of 70 kg)
- Grams (or I.U.) active substance
- Technical measurement unit that allows comparisons

\[
\text{No. DDD} = \frac{\text{No. packages} \times \text{No. tablets per package} \times \text{No. g per tablet}}{\text{DDD of antimicrobial in grams}}
\]
Welcome to our website!

News:

- Proton pump inhibitors (ATC group A02BC) - review of the DDDs in March 2004
- Proposal for a new classification of the cephalosporins (ATC group J01DA)
- Deadlines for applications to the next meeting of the WHO International Working Group for Drug Statistics Methodology
- Open session in connection with the meeting of the WHO International Working Group for Drug Statistics Methodology in March 2004
- Complete ATC index 2004
- Temporary lists of new ATC codes, DDDs and alterations from the October meeting 2003
- New ATC codes, new DDD and ATC/DDD alterations valid from January 2004

Our address:

WHO Collaborating Centre for Drug Statistics Methodology
Norwegian Institute of Public Health
Postboks 4404 Nydalen
0403 Oslo
Norway
Visiting address: Marcus Thrnæs gate 6
0473 Oslo, Norway
Tel: + 47 23 40 81 60
Fax: +47 23 40 81 46
E-mail: whocc@fhi.no

www.whocc.no/atcddd/
ATC/DDD Index 2004

Includes the complete ATC/DDD Index 2004 searchable and free of charge.

Please enter query.

- ATC code
- Name containing query

[Search]

Queries on ATC code or substance name/ATC level name may be entered by ticking the relevant boxes.

ATC code

- All ATC levels are searchable.
- A search will result in showing the exact substance/level and the levels above (up to 1st ATC level).
- It is possible to continue the search by clicking the level names.

Name

- "Name" is defined as the name of the substance (normally the INN name) or the name of the ATC level in question.
- Please note that trademarks are not searchable.
- When entering a substance name, you will see all ATC codes assigned to this substance.
- A minimum of three letters must be entered; a query then may contain part of or the start of a name.
Calculating the Numerator: Examples (1)

- **DOXYCYCLINE 100MG CAP 10**
  - No. grams = No. packages \( \times \) 10 caps per package \( \times \) 0.1 gram per tablet
  - DDD (WHO) for doxycycline = 0.1 gram
  - No. DDDs = No. grams / 0.1

- **DOXYCYCLINE 50MG CAP 28**
  - No. grams = No. packages \( \times \) 28 caps per package \( \times \) 0.05 gram per tablet
  - DDD (WHO) for doxycycline = 0.1 gram
  - No. DDDs = No. grams / 0.1

- **MINOCYCLINE 100MG CAP 56**
  - No. grams = No. packages \( \times \) 56 caps per package \( \times \) 0.1 gram per tablet
  - DDD (WHO) for minocycline = 0.2 gram
  - No. DDDs = No. grams / 0.2
Calculating the Numerator: Examples (2)

- **CIPROFLOXACIN 500MG TAB 20**
  No. grams = No. packages x 20 tablets per package x 0.5 gram per tablet
  DDD (WHO) for ciprofloxacin (oral) = 1 gram
  No. DDDs = No. grams / 1

- **CIPROFLOXACIN 100MG VIAL 50ML x 1**
  No. grams = No. packages x 1 vial (per package) x 0.1 gram per vial
  DDD (WHO) for ciprofloxacin (parenteral) = 0.5 gram
  No. DDDs = No. grams / 0.5

- **CO-AMOXICLAV 375MG (250MG/125MG) TAB 21**
  No. grams = No. packages x 21 tablets per package x 0.25 gram amoxicillin per tablet
  DDD (WHO) for amoxicillin & enzyme inhibitor = 1 gram
  No. DDDs = No. grams / 1
NEW with version 2.0 (2004)! ABC Calc now takes into account not only "Antibacterials for systemic use" also known as group J01 of the ATC classification system, but also antibiotics that are distributed in several other ATC groups, i.e. A02BD (Combinations for eradication of Helicobacter pylori), A07AA (Intestinal antiinfectives, incl. for selective decontamination of the digestive tract), J04A (Drugs for treatment of tuberculosis) and P01A (Agents against amoebiasis and other protozoal diseases). Antibiotics for topical use, which are found in other ATC groups, are excluded.

Suggested citation for this Excel application

References


Acknowledgements
The author is grateful to Marit Rønning & Hege Salvesen Blix (WHO Collaborating Centre for Drug Statistics Methodology, Oslo, Norway) for providing the updated definitions of DDDs and constructive remarks, to Stephanie Natsch (University Medical Center Nijmegen, Nijmegen, The Netherlands), Catherine Billon (Centre Hospitalier de Versailles, Le Chesnay, France), & John M. Stelling (WHO Collaborating Centre for Surveillance of Antimicrobial Resistance, Microbiology Department, Brigham and Women's Hospital, Boston MA, USA) who provided helpful comments about the first version of this application, to Fiona M. MacKenzie (ARPAC project, Aberdeen Royal Infirmary, Aberdeen, Scotland), Robert Vander Stichele, Matus Ferech (ESAC project, Antwerp University, Wilrijk, Belgium) and all users of version 1 whose suggestions helped to further improve this Excel application.

http://www.escmid.org/sites/science/studygroups/index.asp (”ESGAP”, then ”News & Activities”
Introduction to ABC Calc

ABC Calc was developed at the National Center for Antimicrobials and Infection Control, Statens Serum Institut (Copenhagen, Denmark) as part of the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP) and as one of the activities of the European Study Group on Antibiotic Policies (ESGAP) to help members of the microbiology and infectious disease community calculate antibiotic consumption in hospitals and hospitalization units. It is a simple tool that transforms data provided by hospital pharmacies (generally as a number of packages) into meaningful antibiotic consumption rates.

As recommended by the World Health Organization (WHO), ABC Calc reports consumption as a number of Defined Daily Doses (DDD) per 100 bed-days. For a specific drug, the DDD corresponds to the assumed average daily dose for its main indication in adults. DDDs are assigned by the WHO Collaborating Centre for Drug Statistics Methodology (Oslo, Norway) and updated once a year. ABC Calc uses the latest update, i.e. the ATC/DDD Index 2004. Although DDDs might not reflect daily doses used in practice in a specific setting, they should NOT be modified, in order to allow comparisons among hospitals.

NEW with version 2.0 (2004)! ABC Calc now takes into account not only "Antibacterials for systemic use" also known as group J01 of the ATC classification system, but also antibiotics that are distributed in several other ATC groups, i.e. A02BD (Combinations for eradication of Helicobacter pylori), A07AA (Intestinal antiinfectives, incl. for selective decontamination of the digestive tract), J04A (Drugs for treatment of tuberculosis) and P01A (Agents against amoebiasis and other protozoal diseases). Antibiotics for topical use, which are found in other ATC groups, are excluded.

At present, ABC Calc cannot deal with several antibiotic combinations, mainly because DDDs have not been defined for these combinations. Before a solution is found to this problem, we nevertheless encourage users to record information on specialties consisting in antibiotic combinations to help identify the ones that are used in hospitals.

Despite its present limitations, we hope that ABC Calc will help collect antibiotic consumption data from hospitals in Europe and worldwide, and increase awareness about antibiotic misuse in hospitals.

Comments and suggestions are welcomed and can be sent to Dominique L. Monnet at: dom@ssi.dk
**Instructions**

1. Save the file AB Calc 1.8.xls under a new name ("Save as"), e.g. **myABdata.xls**, then open this new file.

2. Go to "Enter consumption data" and enter the names of all antibiotic products stored by the pharmacy and their corresponding number of grams per unit dose and number of unit doses per package. When given in another unit, convert to grams (e.g., 1 million international units (or MIU or MU) benzylpenicillin correspond to 0.6 grams. If a vial of benzylpenicillin contains 5 MU, then the number of grams per unit dose is 3).

**Definitions**

**Unit dose.** Depending on the product, a unit dose corresponds to one tablet, one gelcap, one vial of infusion solution, one vial of mixture, etc. In some instances, users might want to use a volume as a unit dose, e.g. 1 ml infusion solution, 1 ml mixture, etc.

**Package.** Depending on the product, a package corresponds to, for example, a box of 10 tablets, a bag of 500 tablets or a box of 12 vials, etc. In some instances, the package may be equal to the unit dose, e.g. if vials of infusion solution are distributed individually. In this case, the number of unit doses per package is 1.

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibacterial</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2002)</th>
<th>Nr. packages</th>
<th>Nr. grams</th>
<th>Nr. DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carindacillin</td>
<td>0</td>
<td>4</td>
<td></td>
<td>J01CA05</td>
<td>O</td>
<td>4 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacampicillin</td>
<td>0</td>
<td>1.2</td>
<td></td>
<td>J01CA06</td>
<td>O</td>
<td>1.2 g</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See the section "Instructions" for the definitions of "unit dose" and "package".
3. If there is a second product for the same antibiotic name:

- select the corresponding row (number on the left, e.g. below "30")

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibiotic</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2002) U</th>
<th>Nr. packages</th>
<th>Nr. grams</th>
<th>Nr. DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carindacillin</td>
<td>J01CA05</td>
<td>O</td>
<td>4 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacampicillin</td>
<td>J01CA06</td>
<td>O</td>
<td>1.2 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- copy this row ("Edit" then "Copy")

- select the next row (again, by the number on the left)

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibiotic</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2002) U</th>
<th>Nr. packages</th>
<th>Nr. grams</th>
<th>Nr. DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carindacillin</td>
<td>J01CA05</td>
<td>O</td>
<td>4 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacampicillin</td>
<td>J01CA06</td>
<td>O</td>
<td>1.2 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- insert the copied row ("Insert" then "Copied cells")

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibiotic</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2002) U</th>
<th>Nr. packages</th>
<th>Nr. grams</th>
<th>Nr. DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin (2)</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carindacillin</td>
<td>J01CA05</td>
<td>O</td>
<td>4 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacampicillin</td>
<td>J01CA06</td>
<td>O</td>
<td>1.2 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IMPORTANT NOTE: Copied rows must always be inserted in the middle of a group of drugs (delimited by black horizontal lines) and NOT at the beginning or at the end of a group of drugs.
- finally, replace/correct the information about the second product for this antibiotic.

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibacterial</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2002) U</th>
<th>Nr. packages</th>
<th>Nr. grams</th>
<th>Nr. DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMOX 1000 mg INJ FL</td>
<td>1</td>
<td>20</td>
<td>Carindacillin</td>
<td>J01CA05</td>
<td>O</td>
<td>4 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bacampicillin</td>
<td>J01CA06</td>
<td>O</td>
<td>1.2 g</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IMPORTANT NOTE:** As a rule, USERS MUST ONLY WORK WITH WHITE CELLS in ABC Calc. Because they contain reference information or formulas, grey cells must NOT be modified.

Continue until the whole list of products, grams per unit dose and number of unit doses per package is complete.

4. Enter the number of packages of each product which has been consumed during the study period as in the example below. This will automatically calculate the number of grams (or MU) (column M) and the number of DDDs (column N) used during the period.

<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibacterial</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2002) U</th>
<th>Nr. packages</th>
<th>Nr. grams</th>
<th>Nr. DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOX 500 mg GEL</td>
<td>0.5</td>
<td>100</td>
<td>Amoxicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMOX 1000 mg INJ FL</td>
<td>1</td>
<td>20</td>
<td>Carindacillin</td>
<td>J01CA05</td>
<td>O</td>
<td>4 g</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continue until the whole list of number of packages consumed is complete.
5. Finally, go to "Enter hospital data-Get results" and enter information on hospital activity. **Make sure that this information is collected for the same hospitalization units and patient types as for antibiotics.**

This information can be entered:

- either as the number of beds, the occupancy index (e.g., enter 0.85 if 85% of beds were occupied during the study period) and the number of days during the study period. ABC Calc will automatically calculate the number of bed-days using the formula:

  \[ \text{Nr. bed-days (during a specific period) = Nr. beds \times Occupancy index \times Nr. days (during that period)} \]

- or directly as the number of bed-days if readily available. A bed-day corresponds to one occupied hospital bed during one day. The days of admission and discharge are usually counted together as one bed-day.

After calculation or entry of the number of bed-days, ABC Calc will automatically calculate overall consumption of antibacterials and consumption of various classes of antibiotics as a number of grams per 100 bed-days (column I) and as a number of DDD per 100 bed-days (column J).
<table>
<thead>
<tr>
<th>Name of product</th>
<th>Grams per unit dose</th>
<th>Nr. unit doses per package</th>
<th>Name of antibacterial</th>
<th>ATC code</th>
<th>Adm. route</th>
<th>DDD (WHO 2004) U</th>
<th>Nr. packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>J01A - Tetracyclines</td>
<td></td>
<td></td>
<td>Demeclocycline</td>
<td>J01AA01</td>
<td>O</td>
<td>0.6 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Doxycycline</td>
<td>J01AA02</td>
<td>O, P</td>
<td>0.1 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chlortetracycline</td>
<td>J01AA03</td>
<td>O</td>
<td>1 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lymecycline</td>
<td>J01AA04</td>
<td>O, P</td>
<td>0.6 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metacycline</td>
<td>J01AA05</td>
<td>O</td>
<td>0.6 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oxytetracycline</td>
<td>J01AA06</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tetracycline</td>
<td>J01AA07</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Minocycline</td>
<td>J01AA08</td>
<td>O, P</td>
<td>0.2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rolitetracycline</td>
<td>J01AA09</td>
<td>P</td>
<td>0.35 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Penimepicycline</td>
<td>J01AA10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Clomocycline</td>
<td>J01AA11</td>
<td>O</td>
<td>1 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tet.+chlor.+demecl.(115.4:115.4:69.2)</td>
<td>J01AA20</td>
<td>O</td>
<td>0.6 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comb. of tetracyclines (other)</td>
<td>J01AA20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oxytetracycline, combinations</td>
<td>J01AA56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J01B</td>
<td></td>
<td></td>
<td>Chloramphenicol</td>
<td>J01BA01</td>
<td>O, P</td>
<td>3 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thiamphenicol</td>
<td>J01BA02</td>
<td>O, P</td>
<td>1.5 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amoxicillin</td>
<td>J01CA01</td>
<td>O, P, R</td>
<td>2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bacampicillin</td>
<td>J01CA04</td>
<td>O, P</td>
<td>1 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Epicillin</td>
<td>J01CA07</td>
<td>O, P</td>
<td>2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pivmecillinam</td>
<td>J01CA08</td>
<td>O</td>
<td>0.6 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mecillinam</td>
<td>J01CA11</td>
<td>P</td>
<td>1.2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metampicillin</td>
<td>J01CA14</td>
<td>O, P</td>
<td>1.5 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Talampicillin</td>
<td>J01CA15</td>
<td>O</td>
<td>2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Temocillin</td>
<td>J01CA17</td>
<td>P</td>
<td>2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metampicillin</td>
<td>J01CA18</td>
<td>O</td>
<td>2 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pivampi. + pivmecillinam (125:100)</td>
<td>J01CA20</td>
<td>O</td>
<td>1.35 g</td>
<td></td>
</tr>
</tbody>
</table>

See the section "Instructions" for the definitions of "unit dose" and "package".
### Antibacterial use, by ATC level

<table>
<thead>
<tr>
<th>ATC level 2</th>
<th>ATC level 3</th>
<th>ATC level 4</th>
<th>ATC level 5</th>
<th>Nr. beds</th>
<th>Occupancy index (during study period)</th>
<th>Nr. days (during study period)</th>
<th>Nr. bed-days</th>
</tr>
</thead>
<tbody>
<tr>
<td>J01</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01A</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01B</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01C</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01CA</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01CE</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01CF</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01CG</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>J01CR</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Additional level of subdivision (not defined by the official ATC classification system):**

- **PES without anti-pseudomonal activity**
- **PES with anti-pseudomonal activity**
- **PES without anti-pseudomonal activity + BLI**
- **PES with anti-pseudomonal activity + BLI**

**Excl. parenteral colistin (in MU):**

**Nr. grams**

**Nr. DDD**

**Nr. grams per 100 bed-days**

**Nr. DDD per 100 bed-days**

- **J01A - Tetracyclines**
  - 0.0
  - 0.0
  - 0.0
  - 0.0
- **J01B - Amphenicols**
  - 0.0
  - 0.0
  - 0.0
  - 0.0
- **J01C - Beta-lactam antibacterials, Penicillins**
  - 0.0
  - 0.0
  - 0.0
  - 0.0
  - **PES without anti-pseudomonal activity**
    - 0.0
    - 0.0
    - 0.0
    - 0.0
  - **PES with anti-pseudomonal activity**
    - 0.0
    - 0.0
    - 0.0
    - 0.0
  - **J01CE - Beta-lactam sensitive penicillins**
    - 0.0
    - 0.0
    - 0.0
    - 0.0
  - **J01CF - Beta-lactamase resistant penicillins**
    - 0.0
    - 0.0
    - 0.0
    - 0.0
  - **J01CG - Beta-lactamase inhibitors**
    - 0.0
    - 0.0
    - 0.0
    - 0.0
  - **J01CR - Comb. of penicillins (incl. beta-lactamase inhibitors, BLI)**
    - 0.0
    - 0.0
    - 0.0
    - 0.0
Advantages of DDDs

- Independent from price and package size
- One day of treatment receives approximately equal weight whatever the drug, e.g.:
  0.24 g gentamicin $\approx$ 4 g cefotaxime $\approx$ 14 g piperacillin
- Countries/hospitals/wards with similar census, but with different distribution of antimicrobials used, will be counted the same
- Allow fair comparisons among countries, hospitals and wards
Limitations of DDDs

- Cannot not be used in pediatric hospitals/wards
- In hospitals, it does not allow extrapolation to the number of patient exposed (because of e.g. combinations of antimicrobials)
- Does not always correspond to the dose used in routine practice (intensive care, renal failure, prophylaxis) → Prescribed Daily Dose (PDD)
- Does not necessarily correspond to the dose effectively received by the patient…
Prescribed Daily Doses (PDDs)

- Defined locally (hospital, ward) or within a group of hospitals
- PDD = average prescribed dose in the main indication (in this hospital, ward or group of hospitals)
- Grams (or I.U.) active substance
- Do NOT allow inter-hospital comparisons!

\[
\text{No. PDD} = \frac{\text{No. packages} \times \text{No. tablets per package} \times \text{No. g per tablet}}{\text{PDD of antimicrobial in grams}}
\]
Beware of Pseudo-DDDs!

- Presented as DDDs, but are in fact... PDDS
- Several publications mention ”DDDs” but do not use the DDDs defined by the WHO Collaborating Centre
- The references cited for these so-called ”DDDs” are often unclear (e.g. refer to a ”DDD methodology”)
- These pseudo-DDDs are published in journals or on the Internet as DDDs (e.g. CDC’s Project ICARE)

Reasons:
- official (WHO) DDDs unrecognized and/or misunderstood by microbiologists and ID specialists
- it was rather difficult to get these WHO DDDs
Indicators for Benchmarking Antimicrobial Use

Measuring ecological pressure

- Hospitals: in DDD / 100 patient-days (WHO, EU-ARPAC)

\[
\text{Antimicrobial use} = \frac{\text{No. DDDs}}{\text{No. patient-days}} \times 1000
\]

- Hospitals: possibly in PDD / 100 patient-days
- Primary health care: in DDD / 1,000 inhabitant-days (WHO, EU-ESAC)

Measuring patient exposure

- % patients exposed to antimicrobials
- days with at least one antimicrobial / 100 patient-days
Overall Antimicrobial Use in ICUs (1)

**WHO DDD**

0  500  1,000  1,500  2,000  2,500  3,000  3,500  4,000

- Petersen et al.
- Hanberger et al.
- Erlandsson et al.
- Kiivet et al.
- Lemmen et al.
- Vlahovic-Palcevski et al.
- Gruson et al.
- Naaber et al.

**ICARE DDD**

- CDC/ICARE
- MS
- M
- CT
- Cor
- Ped

**PDD**

Bergmans et al.

---

Do not include macrolides and aminoglycosides
Overall Antimicrobial Use in ICUs (2): ICUs vs. Other Inpatient Units vs. Primary Health Care

WHO DDD
- Petersen et al.
- Hanberger et al.
- Erlandsson et al.

ICARE DDD
- CDC/ICARE
- MS
- M
- CT
- Cor
- Ped

Inpatient non-ICU

WHO DDD
- Cars et al.
On a Specified Day…

a patient-day = an inhabitant-day = a person-day

Antimicrobial Consumption (ATC J01), Denmark, 1997

Antimicrobial Consumption in Denmark, 1997-99

Yearly Use of Macrolides (J01FA), Primary Health Care, Denmark, 1997-2001

Yearly and Monthly Use of Macrolides (J01FA), Primary Health Care, Denmark, 1997-2001

Yearly and Monthly Use of Carbapenems (J01DH), Hospital Vega Baja, Orihuela, Spain

Source: López-Lozano JM, Hospital Vega Baja, Orihuela (Alicante), Spain.
Numerator Only Available at Patient Level

- Measure patient exposure
- Prescriptions
- Patients exposed to antimicrobials
- Days with antimicrobials or antimicrobial exposure-days
- Daily antimicrobial treatments
Numerators Available at Patient Level (1)

- **Prescriptions**
  - over-estimate consumption if there is a system to re-evaluate prescriptions

- **Patients exposed to antimicrobials**
  - mostly used in single hospitalization units or for studies on prevalence/incidence of nosocomial infections
Numerators Available at Patient Level (2)

- **Days with antimicrobials or antimicrobial exposure-days**
  - a patient who received several antimicrobials on a single day counts for one day

- **Daily antimicrobial treatments**
  - a patient who received several antimicrobials on a single day counts for as many treatments as the number of antimicrobials received this day
  - should be close to no. PDDs
Overall Antimicrobial Use in ICUs (4)

Days of antimicrobial exposure
- Fischer et al.

Daily antimicrobial treatments
- Petersen et al.
- Monnet et al. (ESAP)

Routinely use SDD
Collective vs. Patient-Level Data

- **Availability** ($ > \text{quantity} > \# \text{doses} > \text{patient info.})

- **Feasibility** (size of database, laws about registers)

- Ecological data cannot take into account misuse of antimicrobials

- Patient-level data do not consider the outcome in other patients

- Antimicrobial resistance is ecological
Conclusions - Recommendations

- Data at collective level for on-going surveillance of antimicrobial use
- In most hospitals, patient-level data for time-limited studies only, e.g. audit of prescriptions, prevalence of nosocomial infections
- To measure ecological pressure and for benchmarking with other institutions and other countries: WHO DDD/100 patient-days
- If other units are used, e.g. PDD/100 patient-days, then one should report the Daily Doses used and should not call them DDDs!