7.2 Klebsiella pneumoniae

Klebsiella spp. are frequent colonizers of the gastrointestinal tract. Although they may also occur in the outpatient setting, they are more frequently found in the hospital setting, affecting patients with an impaired immune system. The most common sites of infection are the urinary tract and the lung (pneumonia). In contrast to *E. coli*, they are intrinsically resistant to aminopenicillins.

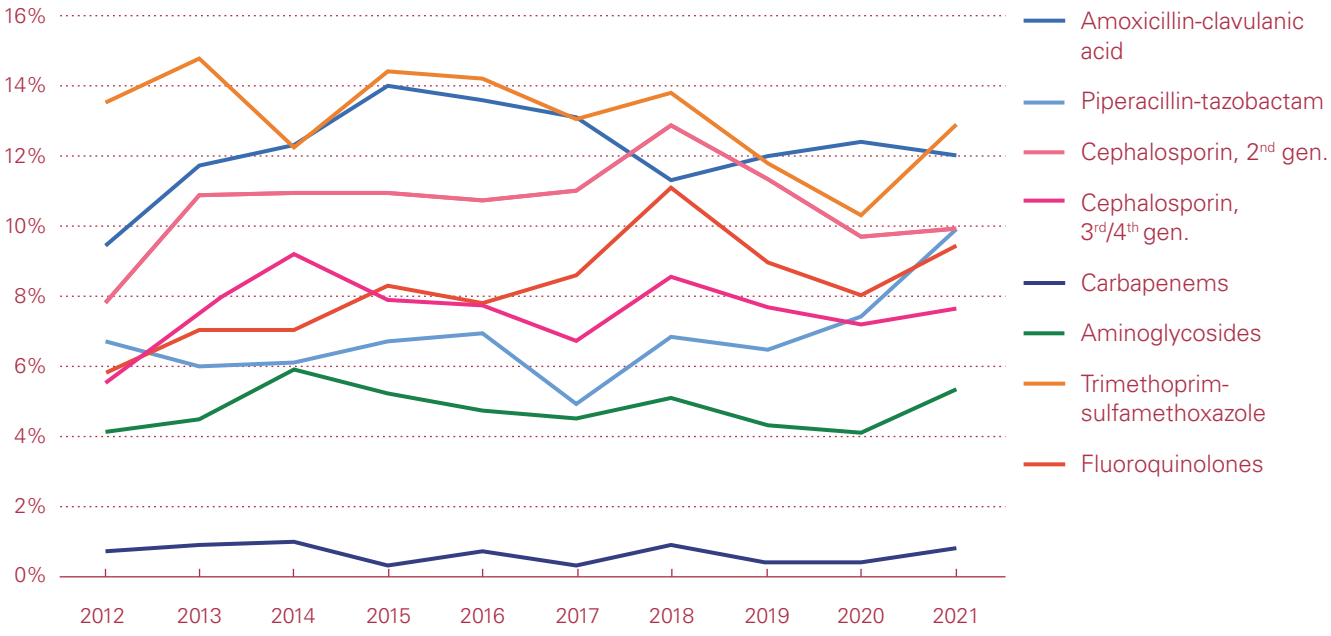
In this report, we present the data on *K. pneumoniae*, which is the most frequent species of the genus *Klebsiella* isolated from human clinical isolates. As species identification is more and more frequently performed by MALDI-TOF since 2017, a growing number of laboratories report *K. variicola* separately from *K. pneumoniae*. In a study from ANRESIS it was shown that *K. variicola* tend to be less resistant than *K. pneumoniae* [7]. However, with regard to homogenization and comparability with international data, other *K. pneumoniae* complex species such as *K. quasipneumoniae* and *K. variicola* are included in the present report. As in *E. coli*, increasing resistance to third-/fourth-generation cephalosporins was a main issue between 2004 (1%) and 2014 (9.2%). However, during the last ten years, the resistance rate has remained stable or has even decreased slightly (but not significantly) to 7.6% in 2021 (Table 7. c, Figure 7. d), which compares favorably with the EU/EEA average of 33.9% in 2020. A stabilization of resistance rates was also

Table 7. c: Resistance rates of invasive *Klebsiella pneumoniae* isolates in humans in 2021.

Klebsiella pneumoniae											**2021**
Antimicrobial	**West**		**North–East**		**South**		**Total**			**Trend**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**95% CI**	**4y**	**10y**
Amoxicillin-clavulanic acid	292	17.5	1,003	10.3	76	13.2	1,371	12	11.1–12.9	–	–
Piperacillin-tazobactam	347	14.4	964	8.5	76	6.6	1,387	9.9	9.1–10.7	↑	↑
Cephalosporin 2nd gen.	154	11	741	9.4	69	11.6	964	9.9	8.9–10.9	↓	–
Cephalosporin 3rd/4th gen.	362	8.8	1,013	7.2	76	7.9	1,451	7.6	6.9–8.3	–	–
Carbapenems[1]	334	0.9	988	0.6	76	2.6	1,398	0.8	0.6–1.0	–	–
Aminoglycosides	313	7	982	4.9	76	2.6	1,371	5.3	4.7–5.9	–	–
Trimethoprim-sulfamethoxazole	362	12.4	943	12.9	76	14.5	1,381	12.9	12.0–13.8	–	↓
Fluoroquinolones[2]	361	11.6	1,013	9	75	4	1,449	9.4	8.6–10.2	–	↑

[1] Carbapenems: imipenem, meropenem
[2] Fluoroquinolones: ciprofloxacin, norfloxacin, ofloxacin
West (GE, NE, VD, JU, FR), South (TI), North–East (other cantons) according to linguistic regions. 95% confidence intervals (CI) were calculated by the Wilson score method, calculations of trends were performed by logistic regression. Trends were modeled with logistic regressions. Arrows represent a significant effect ($p < 0.05$) of the year on the corresponding outcome (increase, decrease).

Figure 7. d: Resistance rates in invasive *Klebsiella pneumoniae* isolates in humans from 2012 to 2021.



observed in EU/EEA states between 2016 and 2020 [2]. Very similar trends were observed for amoxicillin-clavulanic acid, aminoglycosides and trimethoprim-sulfamethoxazole, with maximal resistance rates in 2014/2015. In contrast, for piperacillin-tazobactam and quinolones, significantly increasing resistance rates were observed during the last ten years, i. e., from 6.6% to 9.9% and 5.8% to 9.4%, respectively. No significant trends were observed for carbapenem resistance, which is still below 1% in Switzerland, and therefore much lower than the mean EU/EEA rate, which further increased significantly from 8.4% in 2016 to 10% in 2020.

As for *E. coli*, considerable differences were observed between different Swiss regions (Table 7. c), with higher resistance rates to third-/fourth-generation cephalosporins in western and southern Switzerland and a relatively high resistance rate of 2.6% to carbapenems in southern Switzerland, mirroring higher carbapenem resistance rates in Italy (29.5% in 2020) than in France and Germany (0.5% each in 2020). Several *K. pneumoniae* isolates that produce a carbapenemase and coproduce a 16S rRNA methylase conferring pandrug resistance to all aminoglycosides and/or that are resistant to colistin have been reported throughout Switzerland. Their identification raises the spectrum of truly pandrug resistant *K. pneumoniae* [8]. Pansusceptibility decreased from 90.2% in 2012 to 87% in 2021. Details on coresistances are depicted in Table 7. d and Figure 7. e.

Table 7. d: Resistance combinations in invasive *K. pneumoniae* isolates in humans in 2021. Only isolates tested against all four antibiotic groups (third-generation cephalosporins, carbapenems, aminoglycosides, fluoroquinolones) were considered (n = 1320/1444 [91.4%]).

Resistance patterns	Number of isolates	% of total
Fully susceptible	**1,149**	**87.0%**
Resistance to one antimicrobial group	**82**	**6.2%**
Fluroquinolones	51	3.9%
Third-generation cephalosporins	24	1.8%
Aminoglycoside	7	0.5%
Resistance to two antimicrobial groups	**53**	**4.0%**
Third-generation cephalosporins + fluoroquinolones	29	2.2%
Carbapenems + third-generation cephalosporins	1	0.1%
Aminoglycoside + fluoroquinolones	11	0.8%
Aminoglycoside + third-generation cephalosporins	12	0.9%
Resistance to three antimicrobial groups	**26**	**2.0%**
Carbapenems + third-generation cephalosporins + fluoroquinolones	26	2.0%
Resistance to all four antimicrobial groups	**10**	**0.8%**
Aminoglycoside + carbapenems + third-generation cephalosporins + fluoroquinolones	10	0.8%

Figure 7. e: Multiresistance in invasive *K. pneumoniae* isolates in humans from 2012–2021 (for details refer to Table 7. d).