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Antimicrobial Resistance in Syria

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Abstract

Background Antimicrobial resistance is one of the important and serious public health problems worldwide. Syria has a severe lack of data regarding this problem, especially after war. We aimed from this study to provide a unique snapshot on antimicrobial resistance in Syria.

Methods This is a multi-centric cross-sectional in-vitro study. The results of routine antimicrobial susceptibility tests were collected and analyzes from five major hospitals during the period from 1st March 2018 through 31th October 2018.

Results Final analysis included 2861 isolates. We noticed extremely high rates of antimicrobial resistance among all the species studied. Gram negatives have high resistance rates for cephalosporins. 77% of E.coli, 73% of Klebsiella and 82% of pseudomonas are resistant for ceftriaxone. We also noticed minimal effect of macrolides on gram negatives. 25% of Salmonella typhi strains were resistant to ciprofloxacin. High resistance rates to nitrofurantoin is seen among uropathogenic bacteria. Most gram positive bacteria still have a low resistance rate to vancomycin and linezolid. 54% of staphylococcus aureus and 38% of streptococcus pyogens are resistant to amoxicillin-clavulanate. Resistance rates to Colistin are minimal. The comparison with resistance rates before war reveals the great impact of war on antimicrobial resistance problem.

Conclusion Antimicrobial resistance rates in Syria are worrying. We recommend that the Syrian health authorities apply a policy to restrict the irrational use of antibiotics, and to increase awareness toward antimicrobials use.

Background

Antimicrobial resistance is one of the most important and serious public health problems worldwide, with a dramatically increasing prevalence (1). It is important to know the nature and magnitude of this problem, with periodic updates. This updated knowledge helps with drawing therapeutic guidelines, and making public health policies. Some countries, including Syria, have a severe lack of data related to antimicrobial resistance, especially during war (2)(3). This lack obligates healthcare providers in Syria to use therapeutic guidelines of other countries, or to depend on their own experience. In addition, The war had a great impact on all healthcare aspects, including antimicrobial resistance, which represents a local, regional and global serious risk because of displacement and migration of Syrians (4)(5). This urges researchers to monitor this risk permanently. Abbara *et al.* conducted a review of the existent literature about antimicrobial resistance in Syria, and they gathered the studies from the pre-war and post-war era (6). However, this review appears to be adhered to literature published electronically and in English. Abbara *et al.* found that: "Limited evidence documenting the existence and prevalence of AMR was found in the perusal of the scientific literature. Studies identified were notable for their small size, inconsistent reporting, and questionable methodology, compromising the potential to identify trends or draw conclusions concerning AMR. Most studies were reported from the cities of Damascus and Aleppo, limiting generalization across and to other governorates" (6). We aim from this study to Define the prevalence of in-vitro antimicrobial resistance among key pathogenic bacteria, isolated from human pathologic samples in Syria. This study is the first national, geographically comprehensive, pathogenic-comprehensive and antibiotic-comprehensive study of antimicrobial resistance in Syria. The importance of this study increases because it is conducted during war. This report will help directing clinical practice and public health decisions. Also, it will be of a great value to define the priorities of pharmaceutical industries and humanitarian organizations that provide medicines. In addition, this study will direct further related research.

Results

Final analysis included 2861 isolates: E.coli (744 isolates), Staphylococcus aureus (441 isolates), Enterobacter spp. (375 isolates), Coagulase Negative Staphylococcus (CONS) (312 isolates), Klebsiella spp. (301 isolates), Pseudomonas spp. (282 isolates), G- bacillus (not typed) (68 isolates), Streptococcus agalactia (51 isolates), Proteus spp. (45 isolates), Corynebacterium spp. (40 isolates), Streptococcus viridans (34 isolates), Micrococcus luteus (28 isolates), Moraxella spp. (25 isolates), Streptococcus pneumoniae (25 isolates), Acinetobacter spp. (22 isolates), Salmonella typhi (20 isolates), Enterococcus spp. (19 isolates), Citrobacter spp. (16 isolates), Streptococcus Pyogens (13 isolates).

Antimicrobial resistance rates are presented in table(1).

	Amikacin	Amoxicillin	Amoxicillin + Clavulinic acid	Ampicillin	Ampicillin + Sulbactam
cter spp.	ND	ND	11,11,100%	ND	11,13,85%
r spp.	ND	ND	12,14,86%	ND	10,13,77%
	ND	ND	155,312,50%	131,164,80%	22,113,19%
terium spp.	ND	ND	2,40,5%	ND	4,40,10%
	72,560,13%	36,37,97%	667,744,90%	108,119,91%	335,592,57%
ter spp.	141,306,46%	26,26,100%	317,375,85%	24,29,83%	160,321,50%
cus spp.	ND	ND	7,15,47%	ND	8,15,53%
	ND	ND	59,65,91%	ND	ND
spp.	58,220,26%	37,38,97%	276,299,92%	55,67,82%	159,238,67%
us luteus	ND	ND	5,28,18%	ND	2,27,7%
spp.	0,25,0%	ND	2,25,8%	ND	1,25,4%
p.	4,12,33%	14,21,67%	30,45,67%	ND	14,33,42%
nas spp.	113,249,45%	ND	282,282,100%	ND	194,249,78%
a typhi	ND	16,19,84%	17,20,85%	ND	17,20,85%
ccus aureus	ND	20,20,100%	237,441,54%	33,36,92%	127,374,34%
cus pyogens	ND	ND	5,13,38%	ND	ND
cus	ND	ND	4,51,8%	ND	1,45,2%
cus ae	ND	ND	5,22,23%	ND	5,22,23%
cus viridans	ND	ND	7,34,21%	ND	6,34,18%

(Continued)

n	Azithromycin	Aztreonam	Cefaclor	Cefadroxil	Cefazoline	Cefepime	Cefexime
acter	ND	ND	ND	10,10,100%	ND	10,12,83%	ND
er spp.	ND	ND	ND	ND	ND	12,16,75%	11,12,92%
	8,12,67%	ND	ND	ND	42,106,40%	127,284,45%	ND
cterium	ND	ND	ND	ND	8,37,22%	0,40,0%	ND
	68,78,87%	299,560,53%	30,39,77%	5,26,19%	437,518,84%	480,720,67%	54,70,77%
cter	38,41,93%	202,305,66%	18,26,69%	ND	254,284,89%	219,370,59%	15,32,47%
ccus	ND	ND	ND	ND	9,11,82%	11,15,73%	ND
	ND	ND	ND	ND	ND	45,62,73%	55,59,93%
spp.	36,42,86%	120,220,55%	38,42,90%	7,11,64%	176,200,88%	190,293,65%	20,27,74%
cus	ND	ND	ND	ND	4,28,14%	1,28,4%	ND
spp.	6,11,55%	8,25,32%	ND	ND	5,25,20%	1,25,4%	ND
pp.	ND	4,12,33%	3,21,14%	ND	ND	9,44,20%	8,26,31%
onas	35,43,81%	157,249,63%	ND	ND	219,220,100%	182,277,66%	28,29,97%
a typhi	ND	ND	14,20,70%	ND	ND	4,20,20%	10,19,53%
occus	40,68,59%	ND	27,27,100%	ND	160,349,46%	172,441,39%	48,48,100%
ccus	ND	ND	ND	ND	ND	2,13,15%	ND
ccus	ND	ND	ND	ND	13,38,34%	6,51,12%	ND
ccus iae	ND	ND	ND	ND	5,19,26%	2,22,9%	ND
ccus	ND	ND	ND	ND	9,34,26%	2,34,6%	ND

(Continued)

ı	Cefotaxime	Cefoxitin	Cefpodoxime	Ceftazidime	Ceftriaxon	Ceftriaxon + Sulbactam	Cefuroxime
ıcter	10,10,100%	ND	15,16,94%	11,13,85%	16,17,94%	ND	ND
er spp.	12,15,80%	ND	ND	9,13,69%	14,15,93%	ND	10,11,91%
	188,265,71%	ND	ND	22,59,37%	35,116,30%	24,119,20%	78,198,39%
cterium	1,20,5%	ND	ND	2,19,11%	1,38,3%	0,40,0%	ND
	363,479,76%	12,23,52%	34,50,68%	219,310,71%	497,648,77%	168,561,30%	95,131,73%
cter	155,230,67%	ND	ND	94,170,55%	232,336,69%	80,306,26%	45,61,74%
ccus	ND	ND	ND	ND	12,14,86%	12,15,80%	ND
	34,42,81%	ND	13,13,100%	31,38,82%	44,54,81%	5,5,100%	31,36,86%
spp.	146,193,76%	16,22,73%	10,17,59%	68,105,65%	198,273,73%	85,219,39%	51,61,84%
cus	1,20,5%	ND	ND	1,11,9%	1,28,4%	1,28,4%	ND
. spp.	ND	ND	ND	ND	2,25,8%	0,25,0%	ND
pp.	12,35,34%	ND	ND	7,30,23%	8,41,20%	2,12,17%	9,29,31%
onas	137,168,82%	ND	12,12,100%	83,120,69%	222,270,82%	115,249,46%	17,19,89%
.a typhi	10,19,53%	ND	ND	6,20,30%	10,19,53%	ND	16,20,80%
occus	158,294,54%	36,38,95%	14,14,100%	107,151,71%	191,431,44%	133,369,36%	33,51,65%
ccus	ND	ND	ND	ND	2,12,17%	ND	ND
ccus	5,32,16%	ND	ND	2,21,10%	8,50,16%	3,46,7%	ND
ccus iae	2,13,15%	ND	ND	ND	2,20,10%	2,22,9%	ND
ccus	3,17,18%	ND	ND	ND	5,33,15%	3,34,9%	ND

(continued)

n	Cephalexin	Chloramphenicol	Ciprofloxacin	Clarithromycin	Clindamycin	Colistin
acter	ND	9,11,82%	ND	ND	ND	1,18,6%
er spp.	ND	ND	ND	ND	ND	ND
	162,193,84%	ND	167,289,58%	83,119,70%	69,119,58%	ND
cterium	ND	ND	15,31,48%	25,40,62%	31,40,78%	ND
	96,96,100%	ND	443,634,70%	ND	ND	0,26,0%
cter	28,33,85%	ND	219,341,64%	ND	ND	1,100,1%
ccus	ND	ND	13,14,93%	13,15,87%	16,19,84%	ND
	ND	ND	36,61,59%	ND	16,16,100%	ND
spp.	48,49,98%	0,21,0%	160,272,59%	ND	ND	2,44,5%
cus	ND	ND	5,25,20%	16,28,57%	16,28,57%	ND
. spp.	ND	ND	10,25,40%	ND	ND	ND
pp.	ND	ND	13,36,36%	ND	ND	ND
onas	ND	ND	153,282,54%	ND	ND	5,84,6%
a typhi	ND	ND	5,20,25%	ND	ND	ND
occus	19,21,90%	1,29,3%	234,393,60%	282,369,76%	194,396,49%	ND
ccus	ND	ND	ND	ND	3,10,30%	ND
ccus	ND	ND	19,43,44%	19,46,41%	26,46,57%	ND
ccus iae	ND	ND	10,15,67%	16,22,73%	16,24,67%	ND
ccus	ND	ND	15,33,45%	26,34,76%	19,34,56%	ND

(continued)

	Cotrimoxazole	Doxycyclin	Ertapenem	Erythromycin	Gemifloxacin	Gentamycin
cter spp.	4,11,36%	9,12,75%	ND	ND	ND	15,20,75%
r spp.	12,16,75%	ND	ND	ND	ND	8,13,62%
	207,293,71%	ND	67,119,56%	99,120,82%	ND	112,176,64%
terium	17,32,53%	ND	16,40,40%	32,40,80%	ND	ND
	491,664,74%	32,50,64%	ND	36,36,100%	12,22,55%	432,699,62%
ter spp.	253,341,74%	23,32,72%	ND	28,32,88%	ND	226,356,63%
cus spp.	11,14,79%	ND	12,15,80%	14,17,82%	ND	ND
	ND	27,28,96%	ND	ND	ND	ND
spp.	225,282,80%	16,39,41%	ND	21,21,100%	ND	194,301,64%
us luteus	12,25,48%	ND	7,28,25%	22,28,79%	ND	ND
spp.	15,22,68%	ND	ND	ND	ND	1,25,4%
p.	29,38,76%	20,22,91%	ND	21,23,91%	ND	17,37,46%
nas spp.	250,255,98%	22,22,100%	ND	ND	ND	200,267,75%
a typhi	14,18,78%	18,20,90%	ND	16,20,80%	ND	10,20,50%
occus	205,363,56%	22,41,54%	229,369,62%	323,384,84%	ND	37,51,73%
cus	2,10,20%	ND	ND	5,10,50%	ND	ND
cus	29,45,64%	ND	8,46,17%	26,47,55%	ND	ND
cus ae	18,18,100%	ND	4,22,18%	18,23,78%	ND	ND
cus	15,27,56%	ND	12,33,36%	28,34,82%	ND	ND

(continued)

	Imipenem	Levofloxacin	Lincomycin	Linezolid	Meropenem	Nalidixic acid
cter spp.	15,18,83%	ND	ND	ND	12,14,86%	ND
r spp.	12,16,75%	ND	ND	ND	8,15,53%	ND
	44,295,15%	40,96,42%	ND	6,119,5%	12,119,10%	ND
terium	0,40,0%	9,33,27%	ND	1,40,2%	0,40,0%	ND
	65,741,9%	338,476,71%	ND	ND	47,613,8%	496,598,83%
ter spp.	131,369,36%	174,263,66%	ND	ND	129,312,41%	253,304,83%
cus spp.	5,15,33%	8,10,80%	ND	6,18,33%	5,15,33%	ND
	12,68,18%	ND	25,26,96%	10,10,100%	ND	ND
spp.	60,298,20%	114,181,63%	ND	ND	48,239,20%	182,246,74%
us luteus	0,28,0%	3,26,12%	ND	0,28,0%	0,28,0%	ND
spp.	0,25,0%	7,25,28%	ND	ND	0,25,0%	21,25,84%
p.	3,43,7%	ND	ND	ND	0,15,0%	11,13,85%
nas spp.	119,289,41%	134,217,62%	10,10,100%	ND	106,256,41%	226,248,91%
a typhi	9,20,45%	ND	ND	ND	ND	ND
occus	65,436,15%	167,330,51%	17,31,55%	45,431,10%	59,373,16%	19,25,76%
cus	ND	ND	ND	3,13,23%	ND	ND
cus	1,49,2%	16,39,41%	ND	4,48,8%	2,46,4%	ND
cus ae	1,22,5%	13,20,65%	ND	5,25,20%	1,22,5%	ND
cus	1,34,3%	15,32,47%	ND	2,34,6%	3,34,9%	ND

(continued)

	Netilmycin	Nitrofurantoin	Norfloxacin	Ofloxacin	Oxacillin	Pefloxacin	Penicillin
cter	ND	ND	ND	ND	ND	ND	ND
r spp.	ND	ND	ND	ND	ND	ND	ND
	ND	87,273,32%	132,192,69%	ND	102,119,86%	122,193,63%	91,119,76%
terium	ND	17,38,45%	ND	ND	35,40,88%	ND	31,40,78%
	16,30,53%	269,597,45%	72,73,99%	17,40,42%	ND	57,135,42%	ND
ter	6,26,23%	98,162,60%	21,36,58%	10,26,38%	ND	29,66,44%	ND
cus	ND	8,13,62%	ND	ND	15,15,100%	ND	13,15,87%
	ND	15,38,39%	ND	ND	ND	15,27,56%	ND
spp.	7,17,41%	166,209,79%	33,82,40%	8,34,24%	ND	24,68,35%	ND
us	ND	ND	ND	ND	21,27,78%	ND	22,28,79%
spp.	ND	ND	ND	ND	ND	ND	ND
p.	3,21,14%	18,18,100%	ND	4,21,19%	ND	10,29,34%	ND
nas	ND	82,104,79%	5,17,29%	ND	ND	7,19,37%	ND
a typhi	6,19,32%	ND	ND	7,20,35%	ND	7,20,35%	ND
occus	ND	ND	17,50,34%	4,18,22%	283,366,77%	25,46,54%	341,369,92%
cus	ND	ND	ND	ND	ND	ND	ND
cus	ND	ND	ND	ND	37,45,82%	ND	29,46,63%
cus ae	ND	ND	ND	ND	18,22,82%	ND	14,22,64%
cus	ND	ND	ND	ND	32,34,94%	ND	24,33,73%

(continued)

	Piperacillin + Tazobactam	rifamycin	Teicoplanin	Tetracyclin	Ticarcillin + Clavulinic acid
cter spp.	18,22,82%	ND	ND	11,11,100%	ND
r spp.	2,12,17%	ND	ND	ND	ND
	10,119,8%	2,10,20%	10,121,8%	35,100,35%	ND
terium spp.	0,39,0%	ND	1,40,2%	8,35,23%	ND
	122,643,19%	ND	30,30,100%	398,517,77%	9,11,82%
ter spp.	118,320,37%	ND	23,27,85%	219,293,75%	ND
cus spp.	2,13,15%	ND	4,18,22%	11,17,65%	ND
	ND	ND	ND	ND	ND
spp.	77,256,30%	ND	16,17,94%	167,206,81%	ND
us luteus	0,26,0%	ND	0,28,0%	5,26,19%	ND
spp.	0,25,0%	ND	ND	12,25,48%	ND
p.	4,37,11%	ND	19,21,90%	10,10,100%	ND
nas spp.	108,265,41%	ND	ND	214,238,90%	ND
a typhi	2,15,13%	ND	15,15,100%	ND	ND
occus aureus	43,362,12%	1,21,5%	53,388,14%	138,368,38%	ND
cus pyogens	ND	ND	0,10,0%	ND	ND
cus	2,44,5%	ND	2,47,4%	18,44,41%	ND
cus ae	1,22,5%	ND	4,23,17%	8,23,35%	ND
cus viridans	1,33,3%	ND	0,34,0%	15,32,47%	ND

(continued)

	Tobramycin	Tygacyclin	Vancomycin	Rifampicin	Ceftibuten
cter spp.	10,12,83%	ND	ND	ND	ND
r spp.	ND	ND	ND	ND	ND
	119,193,62%	ND	5,121,4%	ND	ND
terium spp.	ND	ND	ND	ND	ND
	383,667,57%	1,25,4%	30,31,97%	ND	8,30,27%
ter spp.	200,336,60%	ND	26,31,84%	ND	3,22,14%
cus spp.	ND	ND	4,18,22%	ND	ND
not typed)	ND	ND	ND	ND	ND
spp.	161,266,61%	0,10,0%	16,17,94%	19,21,90%	13,17,76%
us luteus	ND	ND	0,28,0%	ND	ND
spp.	0,25,0%	ND	ND	ND	ND
p.	10,16,62%	ND	19,21,90%	ND	8,21,38%
nas spp.	171,268,64%	1,11,9%	ND	ND	ND
a typhi	ND	ND	15,15,100%	ND	6,15,40%
occus aureus	14,18,78%	6,47,13%	33,455,7%	6,48,13%	ND
cus pyogens	ND	ND	2,13,15%	ND	ND
cus agalactia	ND	ND	1,51,2%	ND	ND
cus pneumoniae	ND	ND	2,25,8%	ND	ND
cus viridans	ND	ND	0,34,0%	ND	ND

Table (1). Antimicrobial resistance rates of the studied bacteria. The first number is the absolute number of resistant isolates of the studied bacterium against the studied antibiotic , the second number is the total number of isolates tested against the antibiotic, the third number is the percentage of the resistant strains. ND: No Data.

Discussion

In this study, we report the frequencies of drug resistance of the key bacterial pathogens using the routine results of 5 major centers, that give a considerable representation the Syrian population.

This is the first large, geographically-comprehensive, pathogen-comprehensive study about antimicrobial resistance in Syria.

We notice an extremely high rate of antimicrobial resistance among all the species studied, for most studied antibiotics.

It is important to notice that Acinetobacter spp. Resistance rate was 100% for Amoxicillin- clavulinic acid, cefadroxil, cefotaxime, and tetracyclin. Resistance rate to the tested antibiotics was more than 70%, except for cotrimoxazole (36%) and Colistin (6%), making Colistin the most in-vitro effective for Acinetobacter spp. In Syria, followed by cotrimoxazole.

Cephalosporins have an extremely high rate of resistance, especially in G- bacteria. For example, 77% of E.coli, 73% of Klebsiella and 82% of pseudomonas are resistant for ceftriaxone, a widely used antibiotic for all kinds of infections in Syria. However, Ceftriaxone with sulbactam has lower resistance rates but these rates are still high (table1).

The effect of macrolides on G- bacteria is minimal. 87% and 100% of E.coli strains are resistant to azithromycin and erythromycin, respectively. 86% and 100% of Klebsiella spp. strains are resistant to azithromycin and erythromycin, respectively.

Fortunately, G+ bacteria still have a proportionally low resistance rate to vancomycin. Linezolid is still effective too (table 1). However, resistance rate to linezolid was 23% in streptococcus pyogens and 20% in streptococcus pneumoniae.

Unfortunately, 54% of staphylococcus aureus and 38% of streptococcus pyogens are resistant to amoxicillin with clavulanic acid.

We notice an extremely high rates of resistance to nitrofurantoin among urinary tract infection-related species. For example, 45% of E.coli, 60% of Enterobacter, 79% of Kleibsella, 100% of proteus and 79% of Pseudomonas isolates are resistant to Nitrofurantoin.

Salmonella typhi, a key pathogen in the developing countries, has a high resistance rates to the studied antibiotics, including ciprofloxacin (25%). However, piperacillin with tazobactam and cefepime have the least resistance rate: 13% for piperacillin with tazobactam and 20% for cefepime.

It is worthy to note that resistance rates to Colistin are minimal.

A quick look at table 1 reveals that most bacteria, especially E.coli spp., Enterobacter spp., Klebsiella, Pseudomonas spp. And staphylococcus aureus Have become “superbugs” in Syria.

To better understand the impact of the Syrian war on antimicrobial resistance, we should compare the current data with the pre-conflict data. For example, Al-Omar reported in that the prevalence of Staphylococcus aureus resistance to ampicillin in Misiaf (Tartous Countryside) during 2004 is 69%, and to amoxicillin–Clavulanate is 37% (7), while we found in our study that the prevalence of Staphylococcus aureus resistance to ampicillin is 92%, and to amoxicillin–Clavulanate is 54%.

Obied and Obied in 2005 found that 64% of Streptococcus pneumonia strains in Damascus isolated from CSF were resistant to penicillin, 16% to erythromycin, and 16% to tetracycline, and None resistant to ceftriaxone, cefotaxime, amoxicillin–Clavulanate (8), While we found in our study that that 64% of Streptococcus pneumonia strains were resistant to penicillin, 78% to erythromycin, and 35% to tetracycline, and 10% resistant to ceftriaxone, 15% resistant to cefotaxime and 23% amoxicillin–Clavulanate.

Hussein and Nizzam studied the antimicrobial resistance of bacteria isolated from Otitis media in children of Qamishli in North-eastern Syria, during 2008 and 2009 (9). 0% of Pseudomonas spp. and staphylococcus aureus isolates were resistant for imipenem, but in the current study 41% of Pseudomonas and 15% of Staphylococcus aureus isolates were resistant to Imipenem. In the same study 31% of Pseudomonas isolates and 20% of Klebsiella isolates were resistant to levofloxacin, while in our study 62% of Pseudomonas isolates and 63% of Kleibsella isolates were resistant to levofloxacin

Hamzeh *et al.* conducted a retrospective review of 260 Acinetobacter baumannii isolates from 2008 to 2011 in Aleppo (10). Resistance to specific antibiotics in the latter study was: 65% imipenem, 87% piperacillin– tazobactam,74% cotrimoxazole, 7% Colistin. In our study, Resistance of Acinetobacter spp. strains to the same antibiotics was: 83% imipenem, 82% piperacillin– tazobactam, 36% cotrimoxazole, 6% Colistin. These were just examples of the dramatic growing of the antimicrobial resistance in Syria.

The main reasons for this antimicrobial resistance trend in Syria is the irrational use of antibiotics in Syria. Antibiotics are easily available for people without prescription (11). In addition, the Syrian people do not have enough awareness of antimicrobials use (12)(13). Also, the lack of the diagnostic tests during war urged healthcare providers to treat infections arbitrarily using wide spectrum antibiotics.

During war, healthcare services are damaged, sanitation is poor, health professionals migrate, and exposure in compromised healthcare centers is dramatically increased. War further disrupts the administrative bodies that regularly tackle the drivers of AMR (6).

Although Abbara *et al.* (6) provided a comprehensive review of the existing evidence of antimicrobial resistance in the Syria, We found by electronic search some additional publications that address antimicrobial resistance state in Syria before and after war (9) (15) (16) (17) (18) (19) (20). We mentioned them to make future researchers aware of them. However, an extensive hand-search should be held if we wanted to do a systematic review about antimicrobial resistance in Syria, as most Syrian journals are not indexed in databases, and much research projects in the universities are not published in journals, but indexed in the university library.

This study has major limitations. some valuable information was incomplete, such as: sample type, clinical complaint, wards where the patients were hospitalized in, gender and age of the patients. therefore, we decided to analyze the variables for which we had complete information. In addition, some important bacteria are not included in our study like anaerobes, Shigella, H.pylori,...etc, because : They are usually diagnosed clinically and treated arbitrarily and they need special media and conditions that are not available in our labs, especially during war. In General, there is a lack in the literature reporting the antimicrobial resistance in Syria before and after war, especially fastidious organisms like H.pylori. Another limitation is that much antibiotics are not reported sufficiently, because of the limited availability during war. We have experienced the significant disadvantages of the use of routine results, and of the multi-centric design.

Materials And Methods

This is a multi-centric cross-sectional in-vitro study. The results of routine antimicrobial susceptibility tests were collected from participating centers during the period from 1st March 2018 through 31th October 2018. Data were collected from the following central hospitals: Aleppo University Hospital (Aleppo), Aleppo University Hospital of Obstetrics and Gynecology (Aleppo), Alassad University Hospital (Damascus), Damascus University Hospital of Obstetrics and Gynecology (Damascus). Albassel General Hospital (Tartous). The majority of Syrian patients usually admit to these major hospitals in these major cities, which gives our data a considerable representivity of Syria.

Our target sample was Bacteria isolated from any pathologic sample, on any culture medium, and tested for antimicrobial susceptibility by disc diffusion method.

We excluded duplicate isolates from the same patient, and isolates tested for antimicrobial susceptibility by other methods, like automated methods.

The results were scored as susceptible, intermediate, or resistant according to CLSI criteria (2017) in all collaborating laboratories.

We did statistical analysis using SPSS (version 20.0) . Intermediate results were considered as resistant. For every studied pathogen, We calculated the absolute number of resistant isolates, total number of isolates, and the percentage of resistant isolates tested for every antibiotic. We only reported pathogens with 10 or more isolates tested for the studied antibiotic.

Conclusions

Despite all limitations, our report reflects a unique snapshot of the drug resistance in Syria with information from 5 major centers that would be useful to define better strategies to control drug resistance, and direct current health care and future research in Syria.

We recommend an antibiotics restriction policy to be applied by the health care system in Syria. Health care providers should eliminate or at least restrict antibiotics in which high resistance is observed, and replace them with equivalent antibiotics with low resistance potential. This report may help with directing this replacement procedure. We recommend further well-designed and well-controlled studies to examine the antimicrobial resistance of all pathogenic bacteria to all relevant antibiotics. Finally, This National report should be updated periodically.

Declarations

Ethics approval and consent to participate: This study was approved by the ethical committee of the Faculty of Medicine in University of Damascus and University of Aleppo. The ethical approval was also gained from Albassel Hospital, Tartous city.

Consent for publication: not applicable. Our manuscript does not contain any individual person's data in any form.

Availability of data and materials: The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests: Nothing to declare

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Authors Contributions:

SH and ZS: Study design, data collection and critical review.

A Alhamid: Data collection, study design, statistical analysis, results interpretation and draft writing.

MH, A Albakkar, FA, RN, ZA, AJ, YA, MM, MJ, AS, SM: Data collection, statistical analysis and results interpretation.

All authors have read and approved the final manuscript.

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