Supplementary Material 1: Characteristics of enrolled studies

Figure S1. Flowchart of search strategy.

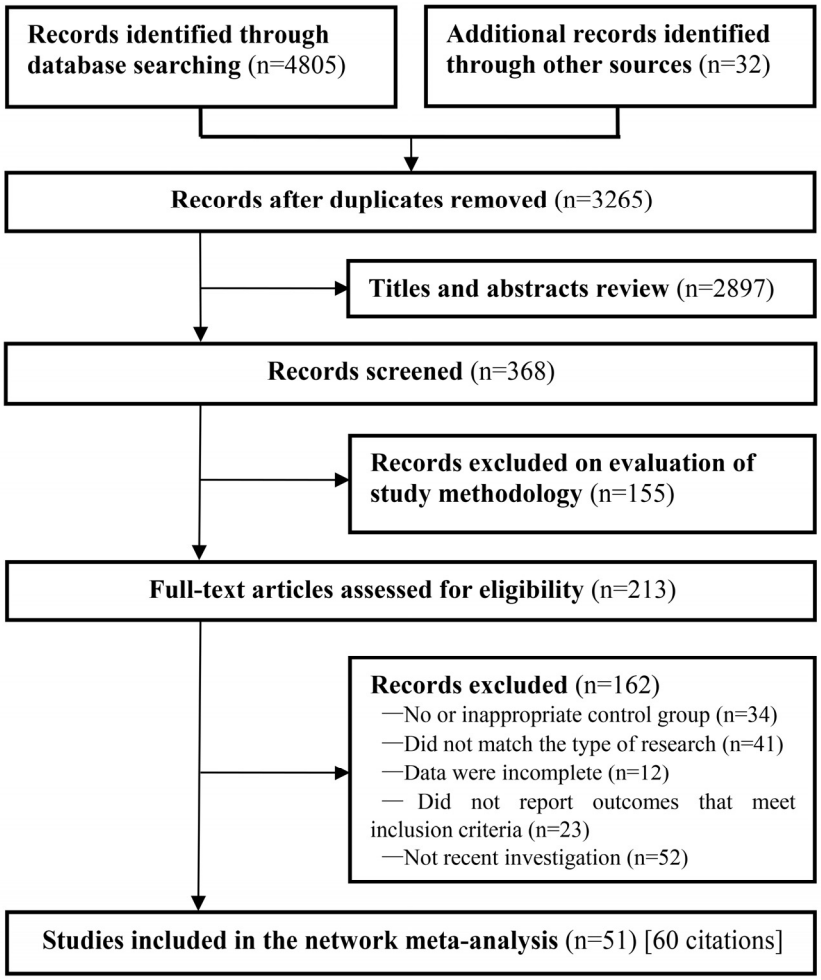

Table S1. Main characteristics of the studies included in the systematic assessment.

			Participant characteristics						Treatment characteristics				Main outcome parameters
Authors (Publication year)	**Recruiting area**	**Study design**	**Sample size (intervention/control)**	**Male (n,%)**	**Mean age (range, years)**	**Antibiotic in use**	**Indication**	**Setting**	**Experimental intervention**	**Comparator arm**	**Dosage** (CFU/day)	**Duration**	
Ahmad et al (2013)	Iran	RCT, double-blind	66 (33/33)	44 (65.7 %)	9.09±3.12 (3~14)	Amoxillin, furazolidone	*H. pylori* eradication	Single site hospital	*Lactobacillus acidophilus* + *Lactobacillus rhamnosus* + *Lactobacillus bulgaricus* + *Lactobacillus casei* + *Streptococcus thermophilus* + *Bifidobacterium infantis* + *Bifidobacterium breve*	Placebo	1 billion	5 weeks	1, 2
Allen et al (2013)	UK	RCT, double-blind, multi-center, two-group	2941 (1471/1470)	2268 (77.12%)	NA	Penicillin, cephalosporin, quinolones, etc.	NA	Multiple hospitals	*Lactobacillus acidophilus* + *Bifidobacterium bifidum* + *Bifidobacterium lactis*	Placebo	60 billion	3 weeks	1, 2, 3

Armuzzi et al (2001)	Italy	Prospective, RCT, double-blind, single-center	60 (30/30)	25 (41.7 %)	40±12	Clarithromycin, tinidazole	*H. pylori* eradication	Asymptomatic, one teaching hospital	*Lactobacillus rhamnosus* GG	Placebo	12 billion	2 weeks	1, 3
Arvola et al (1999)	Finland	RCT, double-blind	119 (61/58)	NA	4.7 (2 weeks~11 years)	NA	Acute reproductive tract infection	In-patient	*Lactobacillus rhamnosus* GG	Placebo	40 billion	7~10 days	1, 2, 3, 4, 5
Beausoleil et al (2007)	Canada	Prospective, RCT, double-blind, single-center	89 (44/45)	43 (48.3 %)	I: 68.8±14.5; C: 72.9±13.4	β-lactams, macrolides, quinolones	Respiratory infection, etc.	Single site hospital	*Lactobacillus acidophilus CL1285 + Lactobacillus casei*	Placebo	25 billion for first 2 days, 50 billion for rest of antibiotic use	Various; the duration of antibiotic use	1, 2, 3
Bravo et al (2008)	Spain	RCT	86(41/45)	20 (23.3 %)	49.78±20.5	Amoxicillin	Acute infection	Out-patient	*Saccharomyces boulardii*	Placebo	10.2 billion	12 days	1

Can et al (2006)	Turkey	Prospective, RCT, double-blind	151 (73/78)	139 (92.1 %)	NA	β-lactams	NA	In-patient, one teaching hospital	*Saccharomyces boulardii*	Placebo	NA	NA	1, 3
Cimperman et al (2011)	USA	RCT, double-blind	31 (15/16)	11 (47.8 %)	I: 42.8; C: 63.6	β-lactams, macrolides, quinolones, etc.	Pneumonia, chronic obstructive pulmonary disease, bronchitis	Acute general medical floor	*Lactobacillus reuteri ATCC 55730*	Placebo	0.2 billion	4 weeks	1
Cindoruk et al (2007)	Turkey	Prospective, RCT, double-blind	124 (62/62)	44 (35.5 %)	I: 45.82±13.35; C: 47.56±13.53	Amoxicillin, clarithromycin	*H. pylori* eradication	NA	*Saccharomyces boulardii*	Placebo	1 g	2 weeks	1, 3
Conway et al (2007) (a)	UK	RCT, double-blind, three-arm	238 (118/120)	114 (42.2 %)	Bio: 37.8±25.3; C: 38.2±23.5	NA	NA	Rural general pratice	*Streptococcus thermophilus + Lactobacillus acidophilus + Bifidobacterium anamails subsp. lactus*	Placebo	1 billion	12 days	1, 3
Conway et al	UK	RCT, double	251 (131/12	111 (42.1	Com: 37.1±23;	NA	NA	Rural general	*Streptococcus thermophilus + Lactobacillus delbrueckii*	Placebo	2 billion	12 days	1, 3

(2007) (b)		-blind, three-arm	0)	%)	C: 38.2±23.5			pratice	*bulgaris*				
Correa et al (2005)	Brazil	RCT, double-blind, formula-controlled, parallel-group	157 (80/77)	60 (38.2 %)	I: 21.94±9.8; C: 22.19±10.7	Ampicillin, amoxicillin, cephalosporin, penicillin, oxacillin, etc.	NA	Hospital ambulatory care	*Bifidobacterium lactis* + *Streptococcus thermophilus*	Placebo	Approximately 5 billion	15 days	1, 4
Cremonini et al (2002) (a)	Italy	RCT, triple-blind, parallel group	42 (21/21)	43 (44.3 %)	18~61	NA	*H. pylori* eradication	Asymptomatic	*Lactobacillus rhamnosus* GG	Placebo	12 billion	2 weeks	1, 3
Cremonini et al (2002) (b)	Italy	RCT, triple-blind, parallel group	42 (21/21)	43 (44.3 %)	18~61	NA	*H. pylori* eradication	Asymptomatic	*Saccharomyces boulardii*	Placebo	10 billion	2 weeks	1, 3
Cremonini et	Italy	RCT, triple-	43 (22/21)	43 (44.3	18~61	NA	*H. pylori* eradicatio	Asymptomatic	*Lactobacillus acidophilus* + *Bifidobacterium lactis*	Placebo	10 billion	2 weeks	1, 3

al (2002) (c)		blind, parallel group		%)			n						
de Vrese et al (2011)	Germany	RCT, double-blind	59 (30/29)	NA	NA	Clarithromycin, amoxicillin	*H. pylori* eradication	Out-patient	*Lactobacillus acidophilus LA-5 + Bifidobacterium animalis ssp. lactis BB-12 + Streptococcus thermophilus*	Placebo	0.75 billion	5 weeks	1, 3
Dietrich et al (2014)	Germany	RCT, double-blind	258 (151/107)	131 (50.8 %)	I: 70.8±15.6; C: 70.8±16.5	Penicillin, cephalosporin, quinolones, etc.	Pulmonary infection, genitourinary infection, biliary infection, sepsis, etc.	A large internal medicine department in primary hospital	*Lactobacillus casei DN-114001*	Placebo	20 billion	12 weeks	1, 2
Duman et al (2005)	Turkey	Prospective, RCT, multi-center, open label	389 (204/185）	190 (48.8 %)	I: 45.68±12.7; C: 44.65±13.9	Amoxicillin, clarithromycin	*H. pylori* eradication	Multiple hospitals	*Saccharomyces boulardii*	Placebo	1 g	2 weeks	1, 2, 3
Engelb	USA	RCT	40(20/2	9	37.2	Amoxicilli	Healthy	Out-pati	*Bifidobacterium lactis Bl-04*	Placebo	41	3 weeks	1

rektson et al (2009)			0)	(22.5 %)		n		ent	+ *Bifidobacterium lactis Bi-07* + *Lactobacillus acidophilus NCFM* + *Lactobacillus paracasei Lpc-37* + *Bifidobacterium bifidum Bb-02*		billion		
Erdeve et al (2004)	Turkey	Prospective, RCT, no treatment controlled	466 (244/222)	NA	1~15	Salbactam-ampicillin, azithromycin	NA	NA	*Saccharomyces boulardii*	Placebo	NA	NA	1
Fox et al (2015)	Australia	Prospective, RCT, double-blind, parallel, multisite, stratifi	70 (34/36)	41 (58.57%)	I: 6.8±2.7, C: 6.3±3.2; (1~12)	β-lactams, macrolides, tetracyclines	Otitis, pharyngitis, chest infection, etc.	Multisite general care	*Lactobacillus rhamnosus* GG + *Bifidobacterium lactis Bb-12* + *Lactobacillus acidophilus La-5*	Placebo	19.4 billion	Various; the duration of antibiotic use plus 1 week	1, 3

		ed										
Gao et al (2010) (a)	USA	RCT, double-blind, single-center, three-arm, dose-ranging	170 (86/84)	85 (50.3 %)	I: 60±6; C: 60±6	Penicillin, cephalosporin, clindamycin	NA	Single site hospital	*Lactobacillus acidophilus CL1285 + Lactobacillus casei LBC80R*	Placebo	100 billion	6~19 days; started within 36h of antibiotic therapy prescribed and continued 5 additional days after antibiotic completion	1, 2, 3
Gao et al (2010) (b)	USA	RCT, double-blind, single-center, three-arm, dose-ranging	169 (85/84)	88 (51.8 %)	I: 60±6; C: 60±6	Penicillin, cephalosporin, clindamycin	NA	Single site hospital	*Lactobacillus acidophilus CL1285 + Lactobacillus casei LBC80R*	Placebo	50 billion	6~19 days; started within 36h of antibiotic therapy prescribed and continued 5 additional days after antibiotic completion	1, 2, 3
Hickson et al (2007)	UK	RCT, double-blind	135 (69/66)	62 (45.9 %)	I: 73.7±11.1; C: 73.9±10.5	NA	Respiratory tract infection, urinary tract	Three hospitals	*Lactobacillus casei DN-114001 + Streptococcu thermophilus + Lactobacillus bulgaricus*	Placebo	40.74 billion	Various; started within 48h of starting antibiotic therapy and continued 1 week after stopping antibiotics	1

						infection						intake	
Hurduc et al (2009)	Romania	Randomized, open trail	90 (48/42)	39 (43.3 %)	11.5	Amoxicillin, Clarothromycin	*H. pylori* eradication	Out-patient	*Saccharomyces boulardii*	Antibiotics-only	500 mg	4 weeks	1, 3
Kim et al (2008)	Korea	Randomized, prospedtive, open-labeled study	347(168/179)	160 (46.1 %)	I: 48.1 ±12.4; C: 53.7 ±12.0	Clarothromycin, amoxicillin	*H. pylori* eradication	Out-patient	*Lactobacillus acidophilus HY 2177 + Lactococcus casei HY 2743 + Bifidobacterium longum HY 8001 + Streptococcus thermophilus B-1*	Antibiotics-only	101.2 million	>3 weeks	1, 3
Koning et al (2008)	The Netherlands	RCT, double-blind, placebo-controlled, parallel	38 (19/19)	NA	18~65	Amoxicillin	NA	Single site hospital	*Bifidobacterium bifidum + Bifidobacterium lactis + Bifidobacterium longum + Enterococcus faecium + Lactobacillus acidophilus + Lactobacillus paracasei + Lactobacillus plantarum + Lactobacillus rhamnosus + Lactobacillus salivarius*	Placebo	10 billion	2 weeks	1, 2, 3
Koning et al (2010)	The Netherlan	RCT, double-blind,	30 (17/13)	19 (63.3 %)	I: 59.9 ±13.3; C: 63.4	Care as usual	Chronic obstructive	Single site hospital	*Bifidobacterium bifidum + Bifidobacterium lactis + Enterococcus faecium +*	Placebo	9 billion	2 weeks	1

	ds	paralle l			±7.4		pulmonary disease		*Lactobacillus acidophilus* + *Lactobacillus paracasei* + *Lactobacillus plantarum* + *Lactobacillus rhamnosus* + *Lactobacillus salivarius*				
Kotow ska et al (2005)	Pola nd	RCT, double -blind	246 (119/12 7)	121 (50%)	I: 39.3±29; C: 39.3±4.1	Cefuroxim e, amoxicilli n, penicillin, clarithrom ycin, roxithromy cin, etc.	Bronchitis, otitis, pneumoni a, tonsillitis, reproducti ve tract infection	Three teaching hospital and two clinics	*Saccharomyces boulardii*	Placebo	500 mg	NA	1, 2, 3
Lionet ti et al (2006)	Italy	RCT	40 (20/20)	21 (52.5 %)	I: 11.0 (3.3~18) ; C: 9.9 (4.3~17. 6)	Amoxicilli n, clarithrom ycin, tinidazole	*H. pylori* eradicatio n	Out-pati ent	*Lactobacillus reuteri ATCC 55730*	Placebo	0.1 billion	20 days	1, 3
Lonne rmark et al (2010)	Swed en	RCT, double -blind	163 (80/83)	79 (48.5 %)	I:47; C: 43	NA	Air way infection, skin/soft tissue infection,	Single site hospital	*Lactobacillus plantarum*	Placebo	10 billion	Various; started within 48h of the introduction of antibiotic therapy and continued 1 week after termination of	1, 2, 3

						urinary infection, etc.						antibiotics	
Merenstein et al (2009)	USA	RCT, double-blind	125 (61/64)	64 (51.2 %)	I: 2.9±1.5; C: 3.2±1.3	NA	Upper respiratory tract infection	Primary care office	*Lactococcus lactis* + *Lactococcus plantarum* + *Lactococcus rhamnosus* + *Lactococcus casei* + *Lactococcus lactis subsp. diacetylactis* + *Leuconostoc cremoris* + *Bifidobacterium longum* + *Bifidobacterium breve* + *Lactobacillus acidophilus* + *Saccharomyces florentinus (yeast)*	Placebo	NA	10 days	1, 3
Morrow et al (2010)	USA	Prospective, RCT, double-blind	146 (73/73)	60 (42.0 %)	I: 52.5±19.3; C: 54.6±16.3	NA	Ventilator-associated pheumonia	Single site hospital	*Lactobacillus rhamnosus* GG	Placebo	4 billion	NA	1, 3
Myllyluoma et al (2005)	Finland	RCT, double-blind	47 (23/24)	18 (38.3 %)	55.6 (24~69)	Amoxicillin, clarithromycin	*H. pylori* eradication	Small companies near research	*Lactobacillus rhamnosus* GG + *Lactobacillus rhamnosus LC705* + *Bifidobacterium breve Bb99* +	Placebo	13 billion for first 1	4 weeks	1, 3

							center	*Propionibacterium freudenreichii ssp. shermanii JS*		week, 6.5 billion for the following 3 weeks			
Nista et al (2004)	Italy	Prospective, RCT, double-blind, single center	106 (54/52)	55 (48.2 %)	I: 46±13; C: 43±13	Amoxicillin, clarithromycin	*H. pylori* eradication	Single site hospital	*Bacillus clausii*	Placebo	6 billion	2 weeks	1, 3
Ouwehand et al (2014) (a)	Finland	RCT, triple-hand, dose-response	335 (168/167)	168 (50%)	High dose: 50.5±11.0; C: 50.0±11.0	Broad spectrum penicillin, cephalosporin, clindamycin	Respiratory tract infection, urinary tract infection	Single site hospital	*Lactobacillus acidophilus + Lactobacillus plaracasei Lpc-37 + Bifidobacterium lactis Bi-07 + Bifidobacterium lactis Bl-04*	Placebo	4.17 billion	10~21 days; length of antibiotic administration plus 1 week	1, 2, 3
Ouwehand et al	Finland	RCT, triple-hand,	335 (168/167)	168 (50.2 %)	Low dose: 49.3±11.	Broad spectrum penicillin,	Respiratory tract infection,	Single site hospital	*Lactobacillus acidophilus + Lactobacillus plaracasei Lpc-37 + Bifidobacterium*	Placebo	17 billion	10~21 days; length of antibiotic administration plus 1	1

(2014) (b)		dose-response		4; C: 50.0±11.0	cephalosporin, clindamycin	urinary tract infection		*lactis Bi-07* + *Bifidobacterium lactis Bl-04*			week	
Plummer et al (2004)	UK	RCT, double-blind	138 (69/69)	NA	NA	NA	NA	In-patient	*Lactobacillus acidophilus* + *Bifidobacterium bifidum*	Placebo	20 billion	20 days	1, 2
Pozzoni et al (2012)	Italy	RCT, double-blind, single-center, parallel-group	204 (106/98)	137 (39.8 %)	I:79.9±9.9; C: 78.5±9.7	β-lactams, quinolones, etc.	NA	Single site hospital	*Saccharomyces boulardii*	Placebo	10 billion	Various; started within 48h of the start of antibiotic therapy and continued 1 week after discontinuation of antibiotics	1, 2, 3
Ruszczynski et al (2008)	Poland	RCT, double-blind	240 (120/120)	110 (45.9 %)	I: 54.8±45.3;C: 53.5±44.25	Penicillins, broad spectrum penicillin, cephalosporin, macrolides	Otitis, upper respiratory tract infection, lower respiratory	Two hospitals and one private practice	*Lactobacillus rhamnosus (E/N, Oxy and Pen)*	Placebo	4 billion	Various; the duration of the antibiotic treatment	1, 2, 3

					, clindamycin	tract infection, urinary tract infection, etc. Pulmonary infection, urinary tract infection, skin/soft tissue infection, etc.							
Safdar et al (2008)	USA	RCT, double-blind, single-center	39 (23/16)	39 (97.5 %)	I: 66.56±14.53; C:72.47 ±11	β-lactams	Single site hospital	*Lactobacillus acidophilus*	Placebo	60 billion	2 weeks	1, 2, 3
Sampalis et al (2010)	Canada	RCT, double-blind, multi-center	437 (216/221)	234 (53.5 %)	I: 59.5±18.1; C: 58.1±19.1	β-lactams, macrolides, quinolones ,clindamycin, etc.	Pulmonary infection, urinary tract infection, skin/soft tissue infection, etc.	8 Canadian centers	*Lactobacillus acidophilus CL1285 + Lactobacillus casei*	Placebo	25 billion for first 2 days, 50 billion for remaining	Various; administered within 24h after the first dose of antibiotics and continued 5 days following the termination of antibiotic regimen	1, 2, 3

											treatment period		
Shan et al (2013)	China	RCT	283 (139/144)	NA	4	Cefepime, cefoperazone, sulbactam, amoxicillin, erthromycin, etc.	Pneumonia, asthma, lower respiratory tract infection	Single site hospital	*Saccharomyces boulardii*	Placebo	500 mg	2 weeks	1, 3
Sheu et al (2002)	China	RCT	160 (80/80)	78 (48.8 %)	I: 47.8; C: 45.9	Amoxicillin, clarithromycin	*H. pylori* eradication	Out-patient	*Lactobacillus* + *Bifidobacterium*	Antibiotics-only	10 billion	1 week	1, 3
Song et al (2010)	Korea	Prospective, RCT, double-blind, multi-center	214 (103/111)	132 (61.7 %)	I: 61±15; C: 60±16	β-lactams, macrolides, quinolones, etc.	Pulmonary infection	10 tertiary hospitals	*Lactobacillus rhamnosus R0011* + *Lactobacillus acidophilus R0052*	Placebo	4 billion	2 weeks	1, 3
Souza et al	Brasil	RCT, double	70 (35/35)	32 (45.7	I: 56.17±2	β-lactams, quinolones	NA	In-patient, single	*Lactobacillus casei* + *Bifidobacterium breve*	Placebo	1.83 billion	Various	1, 3

(2012)		-blind		%)	0.47; C: 54±21.84	, etc.		site hospital					
Sullivan et al (2003)	Sweden	RCT	24 (12/12)	7 (29.2 %)	28 (21~48)	Clindamycin	Healthy	Out-patient	*Lactobacillus acidophilus NCFB 1748 + Bifidobacterium lactis Bb 12 + Lactobacillus paracasei subsp. paracasei F19*	Placebo	50 billion	2 weeks	1
Sykora et al (2005)	UK	Prospective, RCT, double-blind, parallel-group	86 (39/47)	34 (39.5 %)	I: 12.6±3.3; C: 12.9±3.7	Amoxicillin, clarithromycin	*H. pylori* eradication	3 sites hospital general care	*Lactobacillus casei DN-114001*	Placebo	10 billion	1 week	1, 3
Szajewska et al (2009)	Poland	RCT, double-blind	64 (34/30)	39 (47%)	I: 12.3±2.7; C: 11.9±3.1	Amoxicillin, clarithromycin	*H. pylori* eradication	In-patient	*Lactobacillus rhamnosus* GG	Placebo	2 billion	1 week	1, 3
Szymanski et al (2008)	Poland	RCT, double-blind	78 (40/38)	44 (56.4 %)	I: 8 (3~14); C: 7 (1~15)	Amoxicillin, penicillin, cephalospo	Otitis, respiratory tract infection,	Pediatric hospitals and out-patie	*Bifidobacterium longum PL03 + Lactobacillus rhamnosus KL53A + Lactobacillus plantarum*	Placebo	0.2 billion	Various; the duration of the antibiotic treatment	1, 3

					rin, macrolides, etc.	scarlet fever, etc.	nts clinics	*PL02*					
Thomas et al (2001)	USA	Prospective, RCT, double-blind	150 (65/85)	143 (53.6 %)	I: 57.2±18; C: 54.4±17.4	β-lactams	NA	In-patient in single site hospital	*Lactobacillus rhamnosus* GG	Placebo	20 billion	2 weeks	1
Tursi et al (2004)	Italy	Prospective, RCT	70 (35/35)	40 (57.1 %)	I: 58.2 (27~71); C: 54.3 (31~66)	Amoxicillin, tinidazole	*H. pylori* eradication	Out-patient	*Lactobacillus casei subsp. casei DG*	Antibiotics-only	16 billion	10 days	1, 3
Vandehoof et al (1999)	USA	RCT, double-blind	184 (88/96)	85 (45.2 %)	4	Amoxicillin, clarithromycin, cefprozil	Otitis, pharangitis, bronchitis, dermatological, sinusitis	Pediatric hospital	*Lactobacillus rhamnosus* GG	Placebo	10 billion for childrenn weighing <12 kg, 20 billion for weighing >12	10 days	1, 4, 5

											kg		
Wenus et al (2008)	Norway	RCT, double-blind	87 (46/41)	41 (47.1%)	I: 58.8±16.5; C: 56.2±18.7	β-lactams (more than 60% patients)	NA	Single site hospital	*Lactobacillus rhamnosus* GG + *Lactobacillus acidophilus La-5*+ *Bifidobacterium lactis Bb-12*	Placebo	52.5 billion	2 weeks	1, 2
Yoon et al (2011)	Korea	Prospective, RCT, open-label	337 (151/186)	151 (44.8%)	I: 53.7±11.1; C: 55.0±12.5	Moxifloxacin, amoxicillin	*H. pylori* eradication	Out-patient	*Lactobacillus acidophilus HY 2177* + *Lactobacillus casei HY 2743* + *Bifidobacterium longum HY 8001* + *Streptococcus thermophilus B-1*	Antibiotics-only	15.18 billion	4 weeks	1, 3
Zheng et al (2012)	China	Prospective, RCT, multi-center, open-label	372 (193/179)	244 (65.6%)	I: 13.9±9.3; C: 15.8±10	Penicillin, cephalosporin, macrolides	Pneumonia	In-patient	*Clostridium butyricum* + *Bifidobacterium infantis*	Placebo	5 billion	1 week	1

Abbreviations: NA=Not applicable; *H. pylori=Helicobacter pylori*; CFU=Colony forming unit; C=control; I=intervention; RCT=randomized controlled trials; 1=incidence of diarrhea; 2=*Clostridium difficile* infection rate; 3=total occurrence of adverse events; 4=mean duration of diarrhea; 5=mean stool frequency.