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Antimicrobial Resistance's Increased Costs and Hospital Bed Displacement in the US Across Three Major Infections

ID Week

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Conflict of Interest & Disclosures

- Vital Transformation LLC, an international health economics and strategy consultancy, was asked to conduct a retrospective outcomes analysis of the economic impact of the AMR in the United States.
- This study was funded by a consortium of organizations including The Biotechnology Innovation Organization (BIO), Pfizer Inc., Merck & Co., GSK, The Alliance for Aging Research, and the Pharmaceutical Research and Manufacturers of America (PhRMA).
- The analysis was performed by Dr Daniel Gassull, Gwen O'Loughlin, and Duane Schulthess who were paid as consultants by the sponsors of this study.
- The opinions included in this work are those of Vital Transformation LLC, and not necessarily those of the project's sponsors.

Study Design: Retrospective Observational Cohort Study

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Inclusion Criteria

- Subjects admitted as inpatient at index date
- Subjects diagnosed bacterial infections in the form of
  - Sepsis (N = 18,960)
  - Hospital Acquired Pneumonia (N = 15,910)
  - Complicated Urinary Tract Infection (cUTI) (N = 15,319)

Study Cohorts & AMR Classification

- AMR Cohort: Subjects identified through AMR-related ICD-10-CM diagnosis codes, with physician documentation reviewed to validate AMR status.
- Non-AMR Cohort: Subjects with qualifying infections without identified AMR-related ICD-10-CM codes.
- Clinical Documentation Review: physician notes reviewed only for subjects flagged as AMR positive through coding

Outcomes & Endpoints

- Mortality and Clinical Recovery
- Infection Duration, Hospital Length of Stay, and ICU Length of Stay
- Hospital Readmission Rates
- Hospital Costs

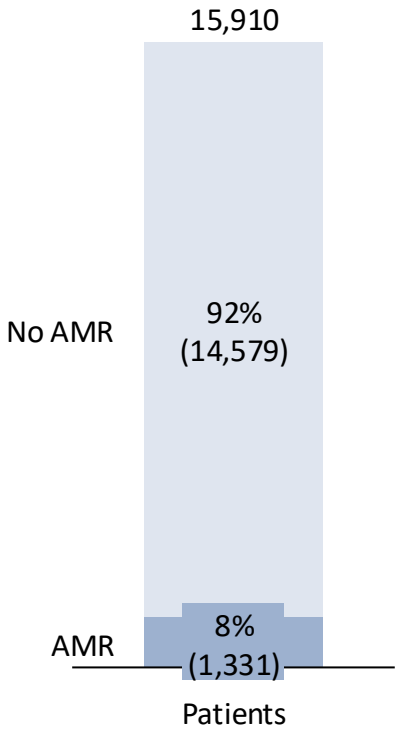
Background: Data, Cohorts, and Methodology

- Our cohort drawn from 4 million longitudinal Electronic Health Records from Vanderbilt University Medical Center (VUMC) in Nashville (TN) through a structured query using ICD-10-CM codes defining the presence of bacterial infection from the years 2016 to 2024.
- Vanderbilt's catchment area includes both urban and rural populations across the southern United States, making it unique in being demographically representative of the US at large:
  - TN (84%), IN (4%), AL (2%), KY (1%), FL (1%), TX (1%), MO (1%), and rest inclusive of NC–MS–AK–(6%)
- Our Index date for an infection is defined by the entry date of ICD-10-CM code describing the infection.
- Subjects were identified with **Sepsis, Hospital Acquired Pneumonia, or cUTI** when at least two ICD-10-CM events for the same infection occurred within 7 days – qualifying events outside of this window were considered a separate infection episode.
- Qualifying infections were identified according to the American Academy of Professional Coders (AAPC) and American Health Information Management Association (AHIMA) guidelines using ICD-10-CM diagnosis codes followed by screening for AMR-related diagnosis codes, primarily Z16 codes. Physician documentation was subsequently reviewed to validate AMR classification in a two-arm test ($N = 200$, $p\text{-value} < 0.0001$) to confirm the methodology.

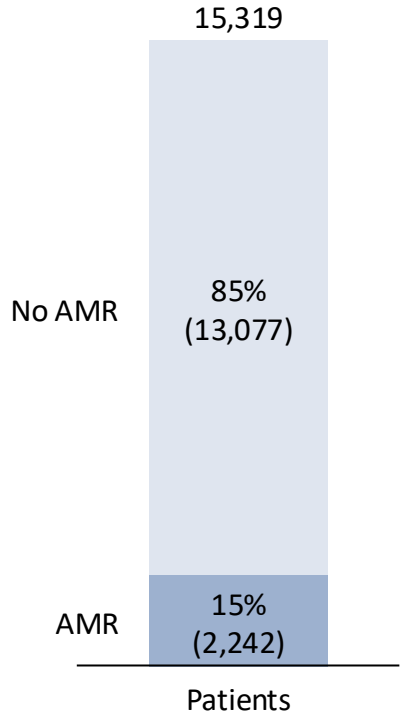
Sepsis



Hospital Acquired Pneumonia



Complicated Urinary Tract Infection (cUTI)



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A balanced cohort for studying direct impact of AMR was generated for each indication

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		Actual Cohort			Balanced Cohort		
Condition	**CCI Score**	**No AMR**	**AMR**	***p* -value**	**No AMR**	**AMR**	***p* -value**
Total Subjects		15820	3140		19244	18684	
Average Age		52.6	53.2	0.112	52.0	53.5	0.013 *
Avg Charlson Comorbidity Index (CCI not adjusted for age)		5.5	7.3	0.000 ***	5.9	5.8	0.567
Avg Charlson Comorbidity Index (CCI)		6.9	8.6	0.000 ***	7.3	7.2	0.673
CCI-based Comorbidities pre-infection							
No Comorbidities	0	2378 (15%)	239 (8%)	0.000 ***	2616 (14%)	2602 (14%)	0.352
Cerebrovascular Disease	1	2718 (17%)	747 (24%)	0.000 ***	3698 (19%)	3510 (19%)	0.284
Chronic Pulmonary Disease	1	4352 (28%)	942 (30%)	0.004 **	5347 (28%)	5204 (28%)	0.876
Congestive Heart Failure	1	4368 (28%)	1088 (35%)	0.000 ***	5524 (29%)	5540 (30%)	0.043
Dementia	1	2427 (15%)	738 (24%)	0.000 ***	3288 (17%)	3120 (17%)	0.313
Diabetes without chronic complications	1	3501 (22%)	961 (31%)	0.000 ***	4515 (23%)	4419 (24%)	0.665
Liver disease, mild	1	3690 (23%)	888 (28%)	0.000 ***	4770 (25%)	4528 (24%)	0.210
Myocardial Infarction	1	2836 (18%)	687 (22%)	0.000 ***	3529 (18%)	3511 (19%)	0.258
Peptic Ulcer Disease	1	724 (5%)	202 (6%)	0.000 ***	933 (5%)	862 (5%)	0.275
Peripheral Vascular Disease	1	2869 (18%)	772 (25%)	0.000 ***	3801 (20%)	3657 (20%)	0.659
Renal disease, mild to moderate	1	4062 (26%)	1087 (35%)	0.000 ***	5365 (28%)	5241 (28%)	0.712
Rheumatic Disease	1	814 (5%)	198 (6%)	0.008 **	1006 (5%)	956 (5%)	0.620
Any malignancy, including fluid tumors	2	2329 (15%)	417 (13%)	0.036 ***	2769 (14%)	2723 (15%)	0.608
Diabetes with Chronic Complications	2	3202 (20%)	890 (28%)	0.000 **	4112 (21%)	4043 (22%)	0.521
Hemiplegia or Paraplegia	2	1171 (7%)	412 (13%)	0.000 ***	1595 (8%)	1553 (8%)	0.932
Liver disease, moderate to severe	3	1070 (7%)	268 (9%)	0.000 ***	1358 (7%)	1330 (7%)	0.816
Renal disease, severe	3	1990 (13%)	674 (21%)	0.000 ***	2886 (15%)	2731 (15%)	0.298
Congestive Heart Failure (severe)	4	504 (3%)	95 (3%)	0.639	602 (3%)	597 (3%)	0.697
AIDS	6	3275 (21%)	1033 (33%)	0.000 ***	4570 (24%)	4224 (23%)	0.009 *
Metastatic Solid Tumor	6	1788 (11%)	279 (9%)	0.000 ***	2063 (11%)	1996 (11%)	0.904
Other Co-morbidities (pre-infection)							
SIRS		614 (4%)	118 (4%)	0.743	730 (4%)	713 (4%)	0.903
Trauamtic Complication		2169 (14%)	694 (22%)	0.000 ***	3048 (16%)	2841 (15%)	0.089
Surgical Complication		1595 (10%)	543 (17%)	0.000 ***	2197 (11%)	2106 (11%)	0.666
Infection following Procedure		1037 (7%)	355 (11%)	0.000 ***	1411 (7%)	1344 (7%)	0.601
Immuno-compromising Therapies							
Chemotherapy (pre-Infection)		1243 (8%)	209 (7%)	0.021 *	1481 (8%)	1386 (7%)	0.300
Chemotherapy (during Infection)		76 (0%)	26 (1%)	0.015 *	95 (0%)	136 (1%)	0.004 **
Anti-inflammatory (pre-infection)		7376 (47%)	1762 (56%)	0.000 ***	9179 (48%)	9464 (51%)	0.000 ***
Anti-inflammatory (during infection)		14258 (90%)	3018 (96%)	0.000 ***	17496 (91%)	17523 (94%)	0.000 ***

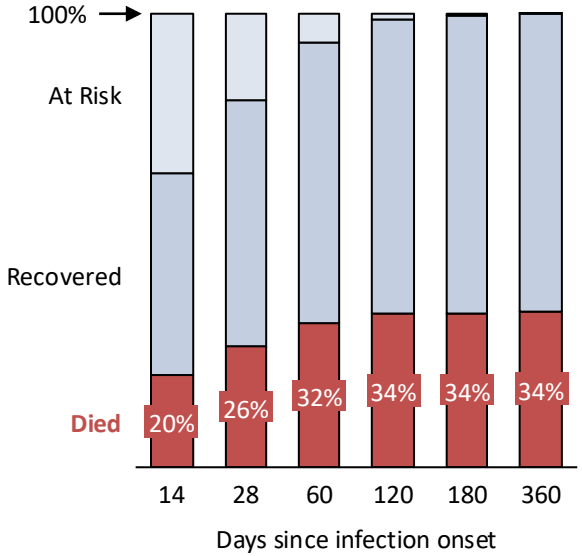
- Balanced AMR and non-AMR cohorts by disease burden can be constructed via the method of Inverse Propensity Treatment Weights (IPTW).
- The table shows that no statistical difference of any co-variates between both groups in the Balanced cohort.
- This method allows us to study the contribution of AMR to Mortality, Length-of-Stay and Costs (i.e. end-points of this study) and Costs.
- The unweighted (Actual) cohorts, on the other hand, form representative samples of the actual hospital setting and, hence, become the baseline for studying the impact of AMR on mortality, length of stay and costs.
- See Appendix

Mortality & Recovery Rates: Sepsis, Pneumonia & complicated UTI

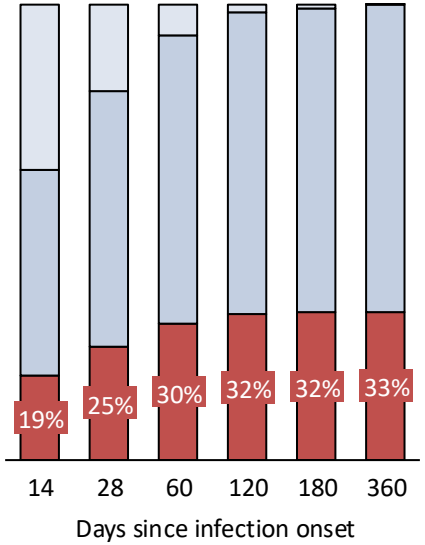
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Nearly 60% of the cumulative one-year mortality risk is observed within the first 14 days following infection onset.

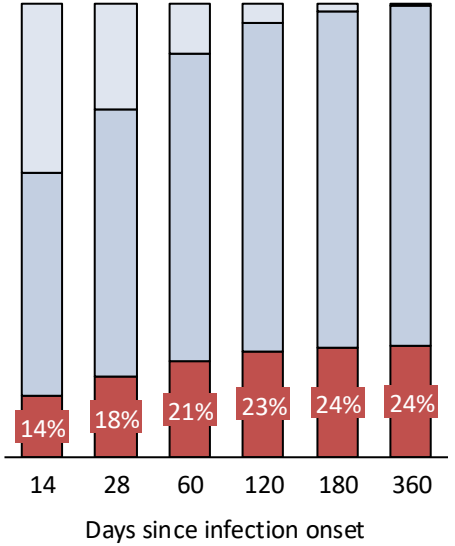
Sepsis



Hospital Acquired Pneumonia



Complicated Urinary Tract Infection (cUTI)



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Summary and Implications

Sepsis, Hospital Acquired Pneumonia and Complicated Urinary Tract Infection

AMR Costs $21,453 per Diagnosis.

Summary of Outcomes	Sepsis	Pneumonia	cUTI	Combined
# of subjects in Cohort Analysed	18,960	15,910	15,319	50,189
AMR resistance	17%	8%	15%	13%
# of subejcts with AMR in Cohort Analysed	3,140	1,331	2,242	6,713
Additional Median Hospital Stay (AMR vs non-AMR)				
Actual Cohort	9	17	7	10
Balanced Cohort	4	8	2	4
Contribution of AMR to Actual	44%	47%	29%	42%
Additional Readmission Rate (AMR vs non-AMR, in %-points)				
Actual Cohort	12%	12%	19%	14%
Balanced Cohort	6%	6%	10%	7%
Contribution of AMR to Actual (in %)	51%	48%	54%	52%
Additional Median Costs of AMR in Actual Cohort (vs non-AMR)				
Medication	503	632	244	442
Procedures	8,497	20,574	4,975	9,715
Hospital Stay	48,167	97,498	29,552	51,731
Total	57,167	118,704	34,771	61,888
Additional Median Costs of AMR in Balanced Cohort (vs non-AMR)				
Medication	204	374	81	197
Procedures	2,993	8,515	1,222	3,497
Hospital Stay	16,288	40,954	6,050	17,759
Total	19,486	49,843	7,353	21,453
% Contribution of AMR to Additional Median Costs on Actual Cohort				
Medication	41%	59%	33%	44%
Procedures	35%	41%	25%	36%
Hospital Stay	34%	42%	20%	34%
Total	34%	42%	21%	35%

- From our dataset of 50,189 subjects in our cohort, 13% had AMR = 6,713
- Our balanced cohort analysis finds that AMR is directly attributable to 4 additional days of hospital stay per diagnosis.
- We find that the medial cost of AMR is roughly **$21,453 per infection**.

AMR is Associated with Substantial Hospital Bed Utilization in the United States

Under current trends, AMR-associated hospital bed utilization is projected to reach 3.5 million bed-days annually by 2045

Estimation of Hospital inpatient Bed Utilization directly attributed with AMR in United States

	2024
Hospital Statistics	
# Hospital Beds in VUMC	1,190
# Hospital Beds in Nashville	3,722
General Population (in M)	
in Nashville Metro Area	1.8
in United States	336.2
AMR Prevalence	
in VUMC	852
in Nashville (EST)	2,665
in United States (EST)	496,405
Additional Inpatient Bed Utilization at VUMC (in days)	
Median additional Hospital Stay	4.1
Bed-days attributed to AMR	3,515
Annual Bed Capacity	434,350
% Capacity attributed to AMR	0.8%
Additional Bed Utilization attributed to AMR	
Total days in United States	2,047,734
# VUMC Hospital-equivalents	4.7

Forecast Hospital Capacity needed for AMR-only in United States
(in M days)

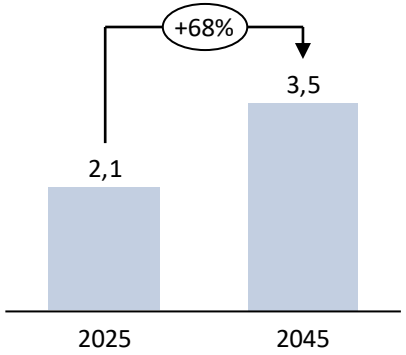


Chart assumes infections grow at +2% annually on top of US population growth (baseline). For lower- (+1%) and upper-case (+3%) scenarios utilization grows by 38% and 105%, respectively.

- Bed utilization directly associated with AMR in VUMC is 3.5k days, about 0.8% of its total annual capacity.
- AMR-associated bed utilization is estimated to be 2M days in United States, which is an equivalent of 4.7x VUMC-equivalent hospitals at full capacity.
- Under current trends, AMR-associated bed utilization is projected to increase by 68% by 2045, occupying the equivalent of 1.3% of current U.S. hospital bed capacity, unless this growing resistance trend can be reversed (* 95% CI [38%, 105%]).

Hospital Readmission Rates increase by roughly 7%-points due to AMR alone

AMR-associated readmissions have economic implications for hospital capacity and costs

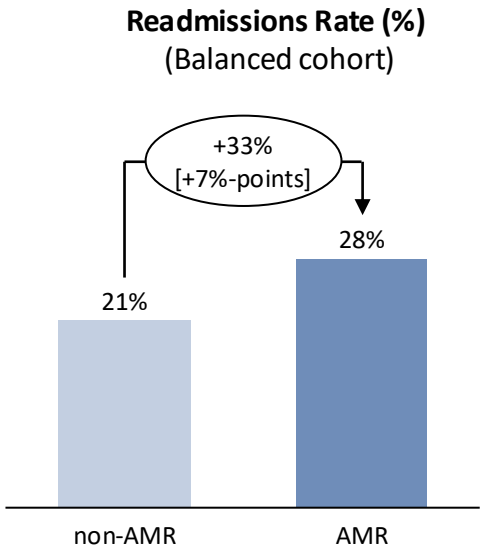


Chart: Weighted average of Readmission Rates of non-AMR and AMR groups adjusted for disease burden and referring to Sepsis, Pneumonia and cUTI combined.

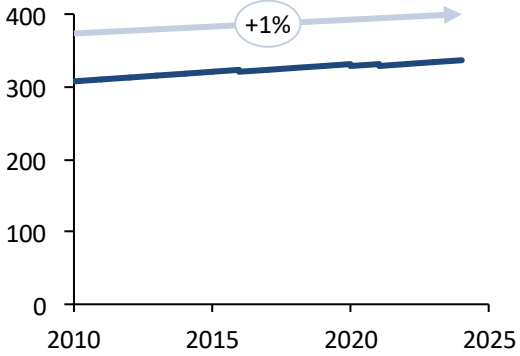
- AMR increases hospital readmission rates associated with these infections by about 1/3 (33%) compared to non-AMR infections.
- Medicare penalties: under Hospital Readmissions Reduction Program (HRRP), hospitals with excess of readmissions face Medicare reimbursement penalties up to 3% annually, stretching financial operating margins of hospitals.
- Re-admission rates of Sepsis, HAP, cUTI are high (about 1/5 of subjects).
- AMR re-admissions add hospital costs.
- New tools, treatments, and diagnosis are required to ensure that dispatched patients do not become reinfected with AMR bacteria.

(1) Hospital Readmissions: Reducing Costs with Innovative Solutions (link)
(2) Anderer S. US Hospital Bed Shortage Looms as Occupancy Rates Climb. JAMA. 2025;333(16):1386. doi:10.1001/jama.2025.2574

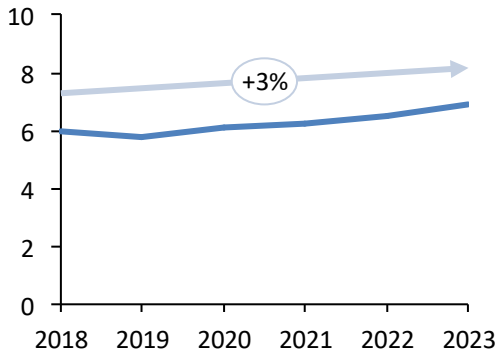
The Share of AMR-Associated Infections Is Increasing

Rising infection rates and AMR prevalence may further intensify the clinical and economic burden on US hospitals over time

Census US population (2016-2023)
(in M)



Incidence of Infections at VUMC
(combined Sepsis, Pneumonia and cUTI, in k)



Share of AMR in VUMC (%)
(combined Sepsis, Pneumonia and cUTI, in k)

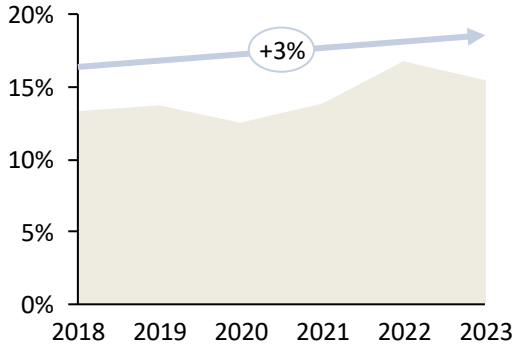


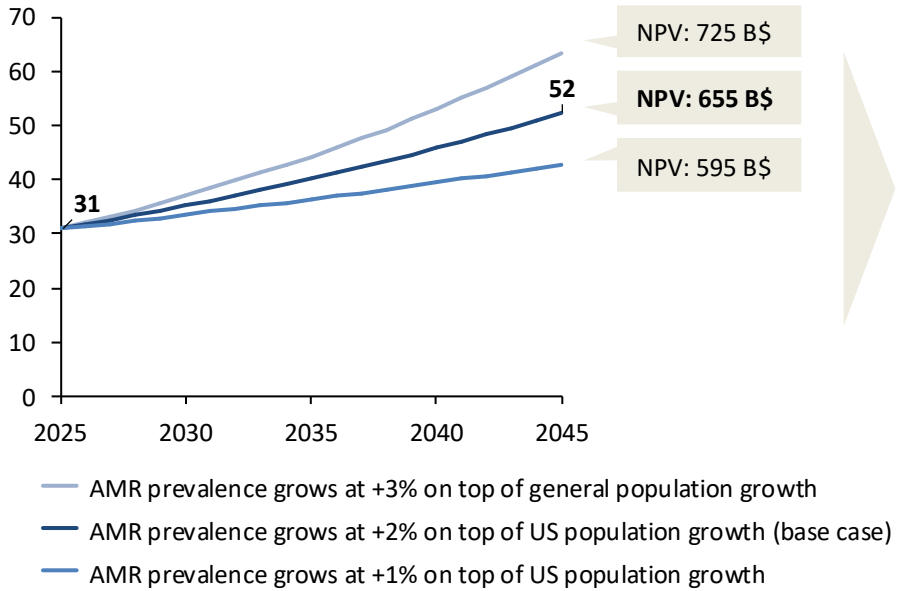
Figure: based on cenus.gov.

- Studied infections outgrow US population by +1%.
- Incidence of AMR outgrows those of infections by +3%-points.
- Factors driving additional growth in these critical infections can be multiple, among which aging and longer life-expectancy of US population (this effect has not been analysed in this study).

The Economic Burden Associated with AMR in the United States

AMR-associated actual costs are projected to rise from $31 billion annually in 2025 to $52 billion by 2045 without more effective interventions.

Projected Annual AMR-Associated Costs in United States
(Different Scenarios based on AMR Incidence, in 2025 B$)



- We estimate the annual cost directly associated with AMR in the US at $31bil in 2025, **rising to $52bil in 2045** (2025 $USD).
- This results in an **NPV of roughly $655 Bil**, range (600-725 varied by ±1% growth rate at the mean).
- This NPV indicates there is room for several drug developments with the potential for a positive return on investment, even at significant price discounts relative to total direct cost of AMR.
- Without investments in prevention, detection, and treatment of AMR, the projected economic burden on the US healthcare system is estimated at 595-725 Bil $US over the next 20 years.

Chart: Projected annual AMR-associated actual costs by year in three different scenarios of AMR growth in relation to US population growth, assumed to continue long-term trend (2010-2024 CAGR: 0.64%). NPV is calculates taking discount rate of 3%. Costs are presented in real values (i.e. in USD of 2025). Values are estimated by extrapolating number of beds in VUMC to Nashville and scaling Nashville population to that of United States.

Key Findings

Measure	Finding
Total cohort	50,189 patients
AMR prevalence	13% (6,713 patients)
Additional hospital stay	4 days directly attributable to AMR per infection
Direct medical cost	$21,453 per AMR infection in balanced cohort
Readmission rate	28% for AMR vs. 21% for non-AMR (+7 percentage points)
US annual AMR cost (2025)	$31 billion in actual costs defined by ICD codes in cohort
Projected US annual cost (2045)	$52 billion (base case)
20-year economic burden	$655 billion NPV

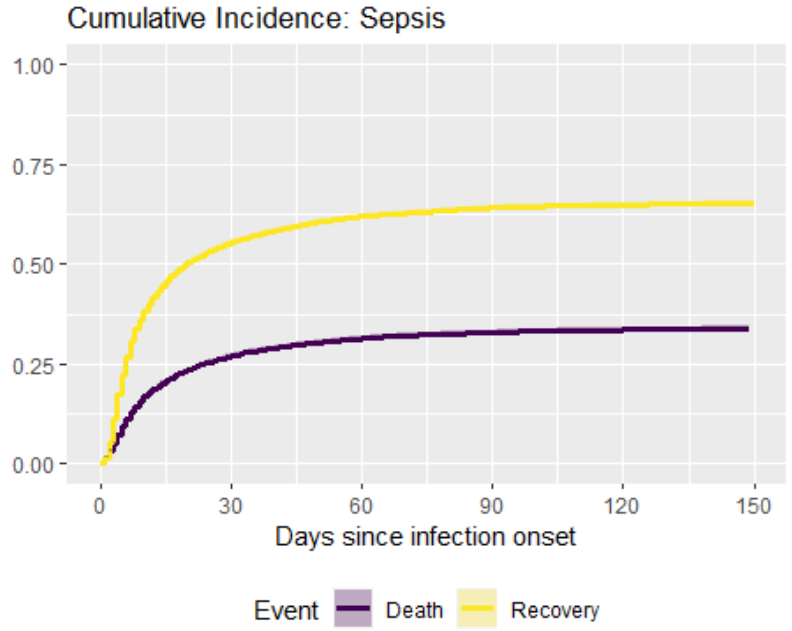
Learn more about the research on our website:

Appendix:

Sepsis: Mortality & Recovery Rates

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Nearly 60% of the cumulative one-year mortality risk is observed within the first 14 days following sepsis onset.



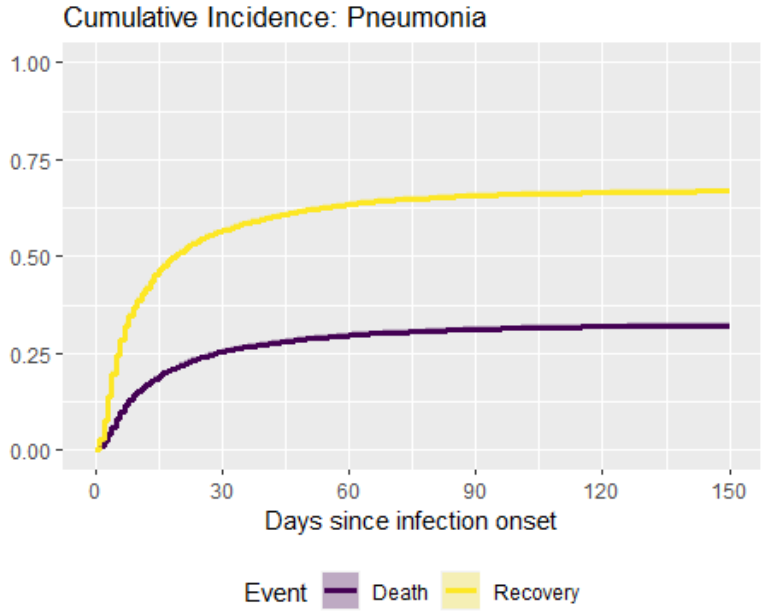
Sepsis	Probability of Death	Probability of Recovery	Prob. Remain infected
14 days	20.2%	44.5%	35.3%
28 days	26.4%	54.6%	19.0%
60 days	31.5%	62.1%	6.5%
120 days	33.6%	64.9%	1.5%
180 days	34.0%	65.5%	0.5%
360 days	34.2%	65.7%	0.1%

Chart & table: Overall Survival with Sepsis taking recovery as competing risk to death. Deaths occurring after infection period are excluded.

Hospital Acquired Pneumonia: Mortality & Recovery Rates

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Nearly 57% of the cumulative one-year mortality risk is observed within the first 14 days following pneumonia onset.

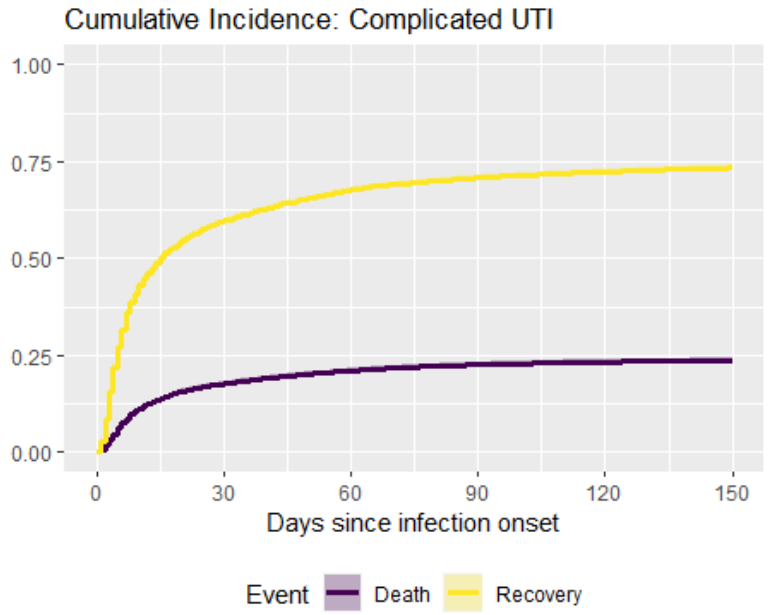


Pneumonia	Probability of Death	Probability of Recovery	at Risk
14 days	18.5%	45.2%	36.3%
28 days	24.9%	55.9%	19.2%
60 days	29.7%	63.4%	6.9%
120 days	32.0%	66.5%	1.6%
180 days	32.3%	67.0%	0.7%
360 days	32.6%	67.3%	0.1%

Chart & table: Overall Survival with Pneumonia taking recovery as competing risk to death. Deaths occurring after infection period are excluded.

cUTI Mortality & Recovery Rates

Nearly 55% of the cumulative one-year mortality risk is observed within the first 14 days following cUTI onset



Complicated UTI	Probability of Death	Probability of Recovery	at Risk
14 days	13.5%	49.1%	37.4%
28 days	17.5%	59.0%	23.6%
60 days	21.1%	67.7%	11.2%
120 days	23.4%	72.4%	4.2%
180 days	24.0%	74.1%	2.0%
360 days	24.4%	75.3%	0.3%

Chart & table: Overall Survival with cUTI taking recovery as competing risk to death. Deaths occurring after infection period are excluded.

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Summary of Outcomes

	Sepsis	Pneumonia	cUTI	Combined	Comments
# of subjects in Cohort Analysed	18,960	15,910	15,319	50,189	
AMR resistance	17%	8%	15%	13%	
# of subejcts with AMR in Cohort Analysed	3,140	1,331	2,242	6,713	
Additional Median Hospital Stay (AMR vs non-AMR)					
Actual Cohort	9	17	7	10	
Balanced Cohort	4	8	2	4	
Contribution of AMR to Actual	44%	47%	29%	42%	
Additional Readmission Rate (AMR vs non-AMR, in %-points)					
Actual Cohort	12%	12%	19%	14%	
Balanced Cohort	6%	6%	10%	7%	
Contribution of AMR to Actual (in %)	51%	48%	54%	52%	
Additional Median Costs of AMR in Actual Cohort (vs non-AMR)					: results comparing Actual AMR vs non-AMR groups
Medication	503	632	244	442	
Procedures	8,497	20,574	4,975	9,715	
Hospital Stay	48,167	97,498	29,552	51,731	
Total	57,167	118,704	34,771	61,888	
Additional Median Costs of AMR in Balanced Cohort (vs non-AMR)					: results comparing Balanced AMR vs non-AMR groups
Medication	204	374	81	197	
Procedures	2,993	8,515	1,222	3,497	
Hospital Stay	16,288	40,954	6,050	17,759	
Total	19,486	49,843	7,353	21,453	
Hosptial Stay Share %	83.6%	82.2%	82.3%	82.8%	
% Contribution of AMR to Additional Median Costs on Actual Cohort					
Medication	41%	59%	33%	44%	
Procedures	35%	41%	25%	36%	
Hospital Stay	34%	42%	20%	34%	
Total	34%	42%	21%	35%	

Hospital Costs of Sepsis

Sepsis Costs per Patient	Median			
	Actual Cohort		Balanced Cohort	
	No AMR	AMR	No AMR	AMR
Medication Costs (in $)				
Cost per Patient	453	956	339	544
Additional Cost of AMR		**503**		**204**
Additional Cost of AMR (%)		111%		60%
Additional Cost attributed to AMR (%)				41%
Hospital Procedure Costs (in $)				
Cost per Patient	8,659	17,156	9,467	12,460
Additional Cost of AMR		**8,497**		**2,993**
Additional Cost of AMR (%)		98%		32%
Additional Cost attributed to AMR (%)				35%
Hospital Stay Costs (in $)				
Average Cost as Inpatient per day	3,025	3,025	3,025	3,025
Average Cost in ICU per day	7,213	7,213	7,213	7,213
Total Hospital Stay Cost per Patient	39,790	87,957	47,004	63,292
Additional Hosp Stay Cost of AMR		**48,167**		**16,288**
Additional Cost of AMR (%)		121%		35%
Additional Cost attributed to AMR (%)				34%
Total Costs (in $)				
Medication	453	956	339	544
Hospital Procedures	8,659	17,156	9,467	12,460
Hospital Stay	39,790	87,957	47,004	63,292
Total (adding totals)	48,903	106,070	56,810	76,296
Additional Costs per Patients of AMR		**57,167**		**19,486**
Additional Cost of AMR (%)		117%		34%
Additional Cost attributed to AMR (%)				34%

- A median AMR Sepsis patient costs $106k to the hospital, which is +117% more than a non-AMR patient, i.e. $48k.
- AMR contributes **$19.5k** (34%) to the additional cost of AMR patient, the rest is associated to patient higher disease burden of the AMR group.

Note: "Balanced Cohort" refers to the IPTW-adjusted cohorts. Instead of averages, medians are studied to prevent skews resulting from long-tail values.

Hospital Costs of Pneumonia

Pneumonia Costs per Patient	Median			
	Actual Cohort		Balanced Cohort	
	No AMR	AMR	No AMR	AMR
Medication Costs (in $)				
Cost per Patient	459	1,091	288	662
Additional Cost of AMR		**632**		**374**
Additional Cost of AMR (%)		138%		130%
Additional Cost attributed to AMR (%)				59%
Hospital Procedure Costs (in $)				
Cost per Patient	8,571	29,145	9,224	17,740
Additional Cost of AMR		**20,574**		**8,515**
Additional Cost of AMR (%)		240%		92%
Additional Cost attributed to AMR (%)				41%
Hospital Stay Costs (in $)				
Average Cost as Inpatient per day	3,025	3,025	3,025	3,025
Average Cost in ICU per day	7,213	7,213	7,213	7,213
Total Hospital Stay Cost per Patient	55,381	152,878	58,406	99,359
Additional Hosp Stay Cost of AMR		**97,498**		**40,954**
Additional Cost of AMR (%)		176%		70%
Additional Cost attributed to AMR (%)				42%
Total Costs (in $)				
Medication	459	1,091	288	662
Hospital Procedures	8,571	29,145	9,224	17,740
Hospital Stay	55,381	152,878	58,406	99,359
Total (adding totals)	64,411	183,115	67,918	117,761
Additional Costs per Patients of AMR		**118,704**		**49,843**
Additional Cost of AMR (%)		184%		73%
Additional Cost attributed to AMR (%)				42%

- A median AMR HAP/VAP patient costs $183k to the hospital, which is +184% more than a non-AMR patient, i.e. $118.7k.
- AMR contributes by **$49.9k** (42%) to the additional cost of AMR patient, the rest is associated to patient higher disease burden of the AMR group.

Note: “Balanced Cohort” refers to the IPTW-adjusted cohorts. Instead of averages, medians are studied to prevent skews resulting from long-tail values.

Hospital Costs of Complicated Urinary Tract Infection

Complicated UTI	Median			
Costs per Patient	Actual Cohort		Balanced Cohort	
	No AMR	AMR	No AMR	AMR
Medication Costs (in $)				
Cost per Patient	248	491	145	226
Additional Cost of AMR		**244**		**81**
Additional Cost of AMR (%)		98%		55%
Additional Cost attributed to AMR (%)				33%
Hospital Procedure Costs (in $)				
Cost per Patient	7,058	12,033	7,417	8,640
Additional Cost of AMR		**4,975**		**1,222**
Additional Cost of AMR (%)		70%		16%
Additional Cost attributed to AMR (%)				25%
Hospital Stay Costs (in $)				
Average Cost as Inpatient per day	3,025	3,025	3,025	3,025
Average Cost in ICU per day	7,213	7,213	7,213	7,213
Total Hospital Stay Cost per Patient	32,577	62,129	35,602	41,652
Additional Hosp Stay Cost of AMR		**29,552**		**6,050**
Additional Cost of AMR (%)		91%		17%
Additional Cost attributed to AMR (%)				20%
Total Costs (in $)				
Medication	248	491	145	226
Hospital Procedures	7,058	12,033	7,417	8,640
Hospital Stay	32,577	62,129	35,602	41,652
Total (adding totals)	39,883	74,653	43,165	50,518
Additional Costs per Patients of AMR		**34,771**		**7,353**
Additional Cost of AMR (%)		87%		17%
Additional Cost attributed to AMR (%)				21%

- A median AMR patient costs $74.7k to the hospital, which is +87% more than a non-AMR patient, i.e. 39.9k$.
- AMR contributes by **$7.3k** (21%) to the additional cost of AMR patient, the rest is associated to patient higher disease burden of the AMR group.

Note: “Balanced Cohort” refers to the IPTW-adjusted cohorts. Instead of averages, medians are studied to prevent skews resulting from long-tail values.

Sepsis IPTW

		Actual Cohort						IPTW balanced cohort						
		n, no-AMR	n, AMR	p, no-AMR	p, AMR	SMD	|SMD|	wtd n, no-AMR	wtd n, AMR	p, no-AMR	p, AMR	SMD	|SMD|	Balance status after weighting
Age band at diagnosis														
Newborn (0-1 month)		417	35	2.6%	1.1%	-0.11	0.11	626	313	3.3%	1.7%	-0.10	0.10	Residual imbalance (0.10-0.25)
Infancy (1m-2yrs)		236	41	2.1%	1.3%	-0.06	0.06	451	236	2.3%	1.3%	-0.08	0.08	Balanced (<0.10)
Childhood (3-12 yrs)		319	51	2.2%	1.6%	-0.04	0.04	443	319	2.3%	1.7%	-0.04	0.04	Balanced (<0.10)
Adolescent (13-18 yrs)		256	45	2.2%	1.4%	-0.06	0.06	424	256	2.2%	1.4%	-0.06	0.06	Balanced (<0.10)
Adult (18-64 yrs)		11,150	1,958	55.8%	62.4%	0.13	0.13	10,691	11,150	55.6%	59.7%	0.08	0.08	Balanced (<0.10)
Elderly (65-84 yrs)		5,955	950	32.6%	30.3%	-0.05	0.05	6,153	5,955	32.0%	31.9%	0.00	0.00	Balanced (<0.10)
Old Elderly (>85 yrs)		455	60	2.5%	1.9%	-0.04	0.04	456	455	2.4%	2.4%	0.00	0.00	Balanced (<0.10)
Charlson Comorbidity Index (CCI)														
CCI score, before age adjustment		5.52	7.27	1.75	3.99	0.44	0.44	5.91	5.84	-0.07	3.90	-0.02	0.02	Balanced (<0.10)
CCI score, age-adjusted (as reported)		6.92	8.60	1.68	n/a	n/a	n/a	7.28	7.23	-0.05	n/a	n/a	n/a	Not derivable
CCI-based comorbidities	**CCI weight**													
AIDS	6	3,275	1,033	21%	33%	0.28	0.28	4,570	4,224	24%	23%	-0.03	0.03	Balanced (<0.10)
Any malignancy (*)	2	2,329	417	15%	13%	-0.04	0.04	2,769	2,723	14%	15%	0.01	0.01	Balanced (<0.10)
Cerebrovascular Disease	1	2,718	747	17%	24%	0.16	0.16	3,698	3,510	19%	19%	-0.01	0.01	Balanced (<0.10)
Chronic Pulmonary Disease	1	4,352	942	28%	30%	0.06	0.06	5,347	5,204	28%	28%	0.00	0.00	Balanced (<0.10)
Congestive Heart Failure	1	4,368	1,088	28%	35%	0.15	0.15	5,524	5,540	29%	30%	0.02	0.02	Balanced (<0.10)
Congestive Heart Failure (severe)	4	504	95	3%	3%	-0.01	0.01	602	597	3%	3%	0.00	0.00	Balanced (<0.10)
Dementia	1	2,427	738	15%	24%	0.21	0.21	3,288	3,120	17%	17%	-0.01	0.01	Balanced (<0.10)
Diabetes with Chronic Complications	2	3,202	890	20%	28%	0.19	0.19	4,112	4,043	21%	22%	0.01	0.01	Balanced (<0.10)
Diabetes without chronic complications	1	3,501	961	22%	31%	0.19	0.19	4,515	4,419	23%	24%	0.00	0.00	Balanced (<0.10)
Hemiplegia or Paraplegia	2	1,171	412	7%	13%	0.19	0.19	1,595	1,553	8%	8%	0.00	0.00	Balanced (<0.10)
Liver disease, mild	1	3,690	888	23%	28%	0.11	0.11	4,770	4,528	25%	24%	-0.01	0.01	Balanced (<0.10)
Liver disease, moderate to severe	3	1,070	268	7%	9%	0.07	0.07	1,358	1,330	7%	7%	0.00	0.00	Balanced (<0.10)
Metastatic Solid Tumor	6	1,788	279	11%	9%	-0.08	0.08	2,063	1,996	11%	11%	0.00	0.00	Balanced (<0.10)
Myocardial Infarction	1	2,836	687	18%	22%	0.10	0.10	3,529	3,511	18%	19%	0.01	0.01	Balanced (<0.10)
Peptic Ulcer Disease	1	724	202	5%	6%	0.08	0.08	933	862	5%	5%	-0.01	0.01	Balanced (<0.10)
Peripheral Vascular Disease	1	2,869	772	18%	25%	0.16	0.16	3,801	3,657	20%	20%	0.00	0.00	Balanced (<0.10)
Renal disease, mild to moderate	1	4,062	1,087	26%	35%	0.20	0.20	5,365	5,241	28%	28%	0.00	0.00	Balanced (<0.10)
Renal disease, severe	3	1,990	674	13%	21%	0.24	0.24	2,886	2,731	15%	15%	-0.01	0.01	Balanced (<0.10)
Rheumatic Disease	1	814	198	5%	6%	0.05	0.05	1,006	956	5%	5%	-0.01	0.01	Balanced (<0.10)
NA	0	2,378	239	15%	8%	-0.24	0.24	2,616	2,602	14%	14%	0.01	0.01	Balanced (<0.10)
Other Commorbidities & Treatments														
SIRS		614	118	4%	4%	-0.01	0.01	730	713	4%	4%	0.00	0.00	Balanced (<0.10)
Traumatic Complication		2,169	694	14%	22%	0.22	0.22	3,048	2,841	16%	15%	-0.02	0.02	Balanced (<0.10)
Traumatic Complication: Mild		340	118	2%	4%	0.10	0.10	570	548	3%	3%	0.00	0.00	Balanced (<0.10)
Traumatic Complication: Severe		1,927	630	12%	20%	0.22	0.22	2,611	2,507	14%	13%	0.00	0.00	Balanced (<0.10)
Surgical Complication		1,595	543	10%	17%	0.21	0.21	2,197	2,106	11%	11%	0.00	0.00	Balanced (<0.10)
Infection following Procedure		1,037	355	7%	11%	0.17	0.17	1,411	1,344	7%	7%	-0.01	0.01	Balanced (<0.10)
Chemotherapy (pre-infection)		990	177	6%	6%	-0.03	0.03	1,182	1,114	6%	6%	-0.01	0.01	Balanced (<0.10)
Anti-inflammatory drugs (pre-infection)		5,134	1,368	32%	44%	0.23	0.23	6,499	6,887	34%	37%	0.06	0.06	Balanced (<0.10)

(*) Any malignancy, including lymphoma and leukemia, except malignant nonmelanom neoplasm of skin

HAP VAP IPTW

		Actual Cohort						IPTW balanced cohort						
		n, no-AMR	n, AMR	p, no-AMR	p, AMR	SMD	|SMD|	wtd n, no-AMR	wtd n, AMR	p, no-AMR	p, AMR	SMD	|SMD|	Balance status after weighting
Age band at diagnosis														
Newborn (0-1 month)		45	5	0.3%	0.4%	0.01	0.01	68	22	0.4%	0.2%	-0.05	0.05	Balanced (<0.10)
Infancy (1m-2yrs)		402	30	5.7%	2.3%	-0.18	0.18	931	402	5.8%	2.7%	-0.15	0.15	Residual imbalance (0.10-0.25)
Childhood (3-12 yrs)		572	39	7.0%	2.9%	-0.19	0.19	1,093	572	6.8%	3.9%	-0.13	0.13	Residual imbalance (0.10-0.25)
Adolescent (13-18 yrs)		373	27	3.2%	2.0%	-0.07	0.07	520	373	3.2%	2.5%	-0.04	0.04	Balanced (<0.10)
Adult (18-64 yrs)		8,141	819	48.2%	61.5%	0.27	0.27	7,822	8,141	48.8%	55.2%	0.13	0.13	Residual imbalance (0.10-0.25)
Elderly (65-84 yrs)		4,871	393	32.4%	29.5%	-0.06	0.06	5,128	4,871	32.0%	33.0%	0.02	0.02	Balanced (<0.10)
Old Elderly (>85 yrs)		375	18	3.1%	1.4%	-0.12	0.12	473	375	2.9%	2.5%	-0.02	0.02	Balanced (<0.10)
Charlson Comorbidity Index (CCI)														
CCI score, before age adjustment		5.58	8.24	2.66	4.06	0.66	0.66	5.85	6.06	0.21	3.93	0.05	0.05	Balanced (<0.10)
CCI score, age-adjusted (as reported)		6.98	9.55	2.57	n/a	n/a	n/a	7.24	7.49	0.25	n/a	n/a	n/a	Not derivable
CCI-based comorbidities	**CCI weight**													
AIDS	6	3,512	613	24%	46%	0.47	0.47	4,241	4,087	26%	28%	0.03	0.03	Balanced (<0.10)
Any malignancy (*)	2	2,359	175	16%	13%	-0.09	0.09	2,537	2,320	16%	16%	0.00	0.00	Balanced (<0.10)
Cerebrovascular Disease	1	3,069	406	21%	31%	0.22	0.22	3,540	3,341	22%	23%	0.01	0.01	Balanced (<0.10)
Chronic Pulmonary Disease	1	5,902	593	40%	45%	0.08	0.08	6,566	6,181	41%	42%	0.02	0.02	Balanced (<0.10)
Congestive Heart Failure	1	4,431	505	30%	38%	0.16	0.16	5,017	4,987	31%	34%	0.05	0.05	Balanced (<0.10)
Congestive Heart Failure (severe)	4	532	37	4%	3%	-0.05	0.05	570	571	4%	4%	0.02	0.02	Balanced (<0.10)
Dementia	1	2,426	403	17%	30%	0.33	0.33	2,944	2,871	18%	19%	0.03	0.03	Balanced (<0.10)
Diabetes with Chronic Complications	2	2,508	340	17%	26%	0.20	0.20	2,870	2,845	18%	19%	0.04	0.04	Balanced (<0.10)
Diabetes without chronic complications	1	2,681	395	18%	30%	0.27	0.27	3,118	3,148	19%	21%	0.05	0.05	Balanced (<0.10)
Hemiplegia or Paraplegia	2	1,219	195	8%	15%	0.20	0.20	1,422	1,209	9%	8%	-0.02	0.02	Balanced (<0.10)
Liver disease, mild	1	2,389	340	16%	26%	0.23	0.23	2,774	2,726	17%	18%	0.03	0.03	Balanced (<0.10)
Liver disease, moderate to severe	3	594	92	4%	7%	0.12	0.12	694	658	4%	4%	0.01	0.01	Balanced (<0.10)
Metastatic Solid Tumor	6	1,571	125	11%	9%	-0.05	0.05	1,696	1,562	11%	11%	0.00	0.00	Balanced (<0.10)
Myocardial Infarction	1	2,645	279	18%	21%	0.07	0.07	2,926	2,719	18%	18%	0.00	0.00	Balanced (<0.10)
Peptic Ulcer Disease	1	488	92	3%	7%	0.16	0.16	580	606	4%	4%	0.03	0.03	Balanced (<0.10)
Peripheral Vascular Disease	1	2,308	325	16%	24%	0.22	0.22	2,656	2,510	17%	17%	0.01	0.01	Balanced (<0.10)
Renal disease, mild to moderate	1	3,327	448	23%	34%	0.24	0.24	3,865	3,709	24%	25%	0.02	0.02	Balanced (<0.10)
Renal disease, severe	3	1,449	275	10%	21%	0.30	0.30	1,801	1,634	11%	11%	0.00	0.00	Balanced (<0.10)
Rheumatic Disease	1	723	82	5%	6%	0.05	0.05	812	794	5%	5%	0.01	0.01	Balanced (<0.10)
NA	0	1,874	58	13%	4%	-0.31	0.31	1,933	1,636	12%	11%	-0.03	0.03	Balanced (<0.10)
Other Commorbidities & Treatments														
SIRS		415	45	3%	3%	0.03	0.03	465	444	3%	3%	0.01	0.01	Balanced (<0.10)
Traumatic Complication		1,477	286	10%	21%	0.32	0.32	1,861	1,700	12%	12%	0.00	0.00	Balanced (<0.10)
Traumatic Complication: Mild		197	35	1%	3%	0.09	0.09	227	242	1%	2%	0.02	0.02	Balanced (<0.10)
Traumatic Complication: Severe		1,319	270	9%	20%	0.32	0.32	1,688	1,548	11%	10%	0.00	0.00	Balanced (<0.10)
Surgical Complication		761	193	5%	15%	0.32	0.32	1,056	1,015	7%	7%	0.01	0.01	Balanced (<0.10)
Infection following Procedure		290	98	2%	7%	0.26	0.26	456	383	3%	3%	-0.02	0.02	Balanced (<0.10)
Chemotherapy (pre-infection)		888	74	6%	6%	-0.02	0.02	957	829	6%	6%	-0.02	0.02	Balanced (<0.10)
Anti-inflammatory drugs (pre-infection		4,962	577	34%	43%	0.19	0.19	5,594	5,286	35%	36%	0.02	0.02	Balanced (<0.10)

(*) Any malignancy, including lymphoma and leukemia, except malignant nonmelanom neoplasm of skin

cUTI IPTW

		Actual Cohort						IPTW balanced cohort						
		n, no-AMR	n, AMR	p, no-AMR	p, AMR	SMD	|SMD|	wtd n, no-AMR	wtd n, AMR	p, no-AMR	p, AMR	SMD	|SMD|	Balance status after weighting
Age band at diagnosis														
Newborn (0-1 month)		58	27	0.4%	1.2%	0.08	0.08	105	192	0.7%	1.3%	0.06	0.06	Balanced (<0.10)
Infancy (1m-2yrs)		804	93	4.2%	4.1%	0.00	0.00	683	804	4.4%	5.3%	0.04	0.04	Balanced (<0.10)
Childhood (3-12 yrs)		400	56	2.0%	2.5%	0.03	0.03	311	400	2.0%	2.7%	0.04	0.04	Balanced (<0.10)
Adolescent (13-18 yrs)		313	49	2.2%	2.2%	0.00	0.00	343	313	2.2%	2.1%	-0.01	0.01	Balanced (<0.10)
Adult (18-64 yrs)		6,399	1,069	43.3%	47.7%	0.09	0.09	6,771	6,399	43.9%	42.4%	-0.03	0.03	Balanced (<0.10)
Elderly (65-84 yrs)		6,197	862	42.5%	38.4%	-0.08	0.08	6,418	6,197	41.6%	41.1%	-0.01	0.01	Balanced (<0.10)
Old Elderly (>85 yrs)		778	86	5.4%	3.8%	-0.07	0.07	785	778	5.1%	5.2%	0.00	0.00	Balanced (<0.10)
Charlson Comorbidity Index (CCI)														
CCI score, before age adjustment		4.96	6.65	1.69	3.77	0.45	0.45	5.23	5.27	0.04	3.63	0.01	0.01	Balanced (<0.10)
CCI score, age-adjusted (as reported)		6.75	8.29	1.53	n/a	n/a	n/a	6.99	7.01	0.03	n/a	n/a	n/a	Not derivable
CCI-based comorbidities	**CCI weight**													
AIDS	6	2,081	622	16%	28%	0.29	0.29	2,748	2,754	18%	18%	0.01	0.01	Balanced (<0.10)
Any malignancy (*)	2	1,579	277	12%	12%	0.01	0.01	1,854	1,882	12%	12%	0.01	0.01	Balanced (<0.10)
Cerebrovascular Disease	1	3,189	546	24%	24%	0.00	0.00	3,778	3,688	25%	24%	0.00	0.00	Balanced (<0.10)
Chronic Pulmonary Disease	1	3,174	630	24%	28%	0.09	0.09	3,826	3,748	25%	25%	0.00	0.00	Balanced (<0.10)
Congestive Heart Failure	1	3,161	704	24%	31%	0.16	0.16	3,926	3,902	25%	26%	0.01	0.01	Balanced (<0.10)
Congestive Heart Failure (severe)	4	402	57	3%	3%	-0.03	0.03	458	476	3%	3%	0.01	0.01	Balanced (<0.10)
Dementia	1	2,759	581	21%	26%	0.11	0.11	3,357	3,254	22%	22%	-0.01	0.01	Balanced (<0.10)
Diabetes with Chronic Complications	2	2,734	650	21%	29%	0.19	0.19	3,420	3,399	22%	23%	0.01	0.01	Balanced (<0.10)
Diabetes without chronic complications	1	2,639	580	20%	26%	0.14	0.14	3,262	3,148	21%	21%	-0.01	0.01	Balanced (<0.10)
Hemiplegia or Paraplegia	2	1,610	366	12%	16%	0.11	0.11	1,982	1,892	13%	13%	-0.01	0.01	Balanced (<0.10)
Liver disease, mild	1	2,148	515	16%	23%	0.17	0.17	2,692	2,585	17%	17%	-0.01	0.01	Balanced (<0.10)
Liver disease, moderate to severe	3	568	132	4%	6%	0.07	0.07	739	670	5%	4%	-0.02	0.02	Balanced (<0.10)
Metastatic Solid Tumor	6	1,147	190	9%	8%	-0.01	0.01	1,337	1,323	9%	9%	0.00	0.00	Balanced (<0.10)
Myocardial Infarction	1	2,046	396	16%	18%	0.05	0.05	2,442	2,414	16%	16%	0.00	0.00	Balanced (<0.10)
Peptic Ulcer Disease	1	422	112	3%	5%	0.09	0.09	568	534	4%	4%	-0.01	0.01	Balanced (<0.10)
Peripheral Vascular Disease	1	2,055	449	16%	20%	0.11	0.11	2,553	2,429	17%	16%	-0.01	0.01	Balanced (<0.10)
Renal disease, mild to moderate	1	3,735	887	29%	40%	0.23	0.23	4,656	4,643	30%	31%	0.01	0.01	Balanced (<0.10)
Renal disease, severe	3	1,427	428	11%	19%	0.23	0.23	1,890	1,863	12%	12%	0.00	0.00	Balanced (<0.10)
Rheumatic Disease	1	728	154	6%	7%	0.05	0.05	878	867	6%	6%	0.00	0.00	Balanced (<0.10)
NA	0	1,943	237	15%	11%	-0.13	0.13	2,186	2,189	14%	15%	0.01	0.01	Balanced (<0.10)
Other Commorbidities & Treatments														
SIRS		297	60	2%	3%	0.03	0.03	354	326	2%	2%	-0.01	0.01	Balanced (<0.10)
Traumatic Complication		1,219	305	9%	14%	0.13	0.13	1,587	1,505	10%	10%	-0.01	0.01	Balanced (<0.10)
Traumatic Complication: Mild		225	50	2%	2%	0.04	0.04	294	244	2%	2%	-0.02	0.02	Balanced (<0.10)
Traumatic Complication: Severe		1,041	270	8%	12%	0.14	0.14	1,355	1,326	9%	9%	0.00	0.00	Balanced (<0.10)
Surgical Complication		688	190	5%	8%	0.13	0.13	928	919	6%	6%	0.00	0.00	Balanced (<0.10)
Infection following Procedure		362	102	3%	5%	0.09	0.09	463	492	3%	3%	0.01	0.01	Balanced (<0.10)
Chemotherapy (pre-infection)		553	106	4%	5%	0.02	0.02	649	664	4%	4%	0.01	0.01	Balanced (<0.10)
Anti-inflammatory drugs (pre-infection		4,135	1,023	32%	46%	0.29	0.29	5,149	5,648	33%	37%	0.08	0.08	Balanced (<0.10)

(*) Any malignancy, including lymphoma and leukemia, except malignant nonmelanom neoplasm of skin