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Multidrug resistance in Ukrainian combat trauma

What we measured - and where the evidence ends

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2022

Our hospital changed dramatically.

Within months, First Lviv Territorial Medical Union became one of the largest centres in Ukraine treating patients with severe combat trauma - patients requiring multiple surgeries, prolonged ICU stays, complex reconstruction and long-term rehabilitation.

Alongside this new patient population, we observed a profound change in the microbiology of our hospital.

First Lviv Territorial Medical Union: where these patients arrive

500 000⁺

patients per year catchment,
not the trauma cohort

63 087

surgical interventions, 2025

3 000

specialised beds

140 anaesthesiology &
ICU beds — one of
Ukraine's largest ICUs

411 rehabilitation beds ·
6 100+ staff

27 000⁺

wounded at the UNBROKEN
Rehabilitation Centre since
the full-scale invasion

1 193 prostheses

Multidrug-resistant organisms in wounds



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PREVIOUSLY
MRSA - methicillin-resistant *S. aureus*

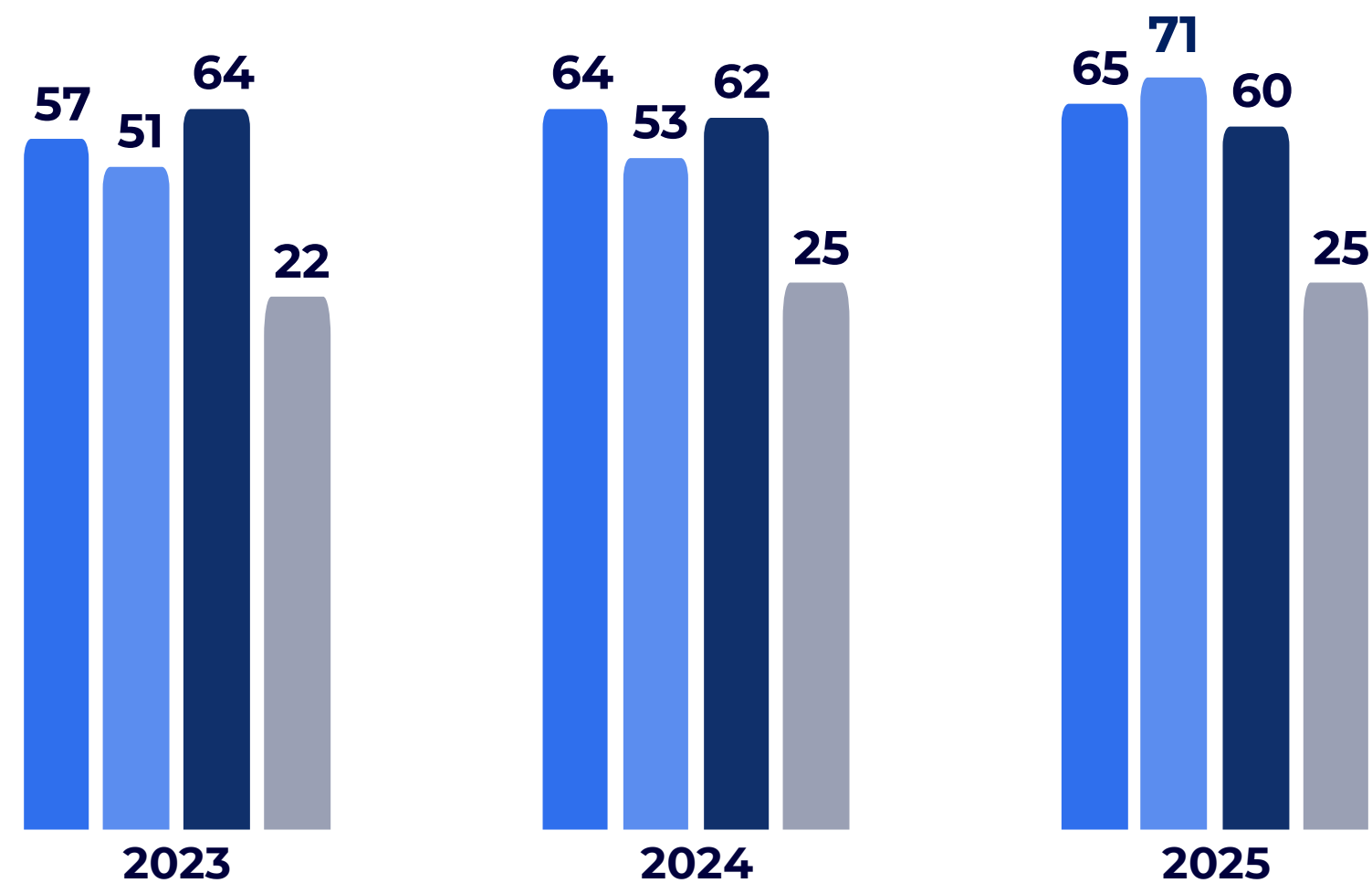


TODAY
Carbapenem-resistant gram-negatives - *A. baumannii*, *K. pneumoniae*, *P. aeruginosa*

MDROs cultured from wounds, 2023–2025

carbapenem-resistant, % of isolates

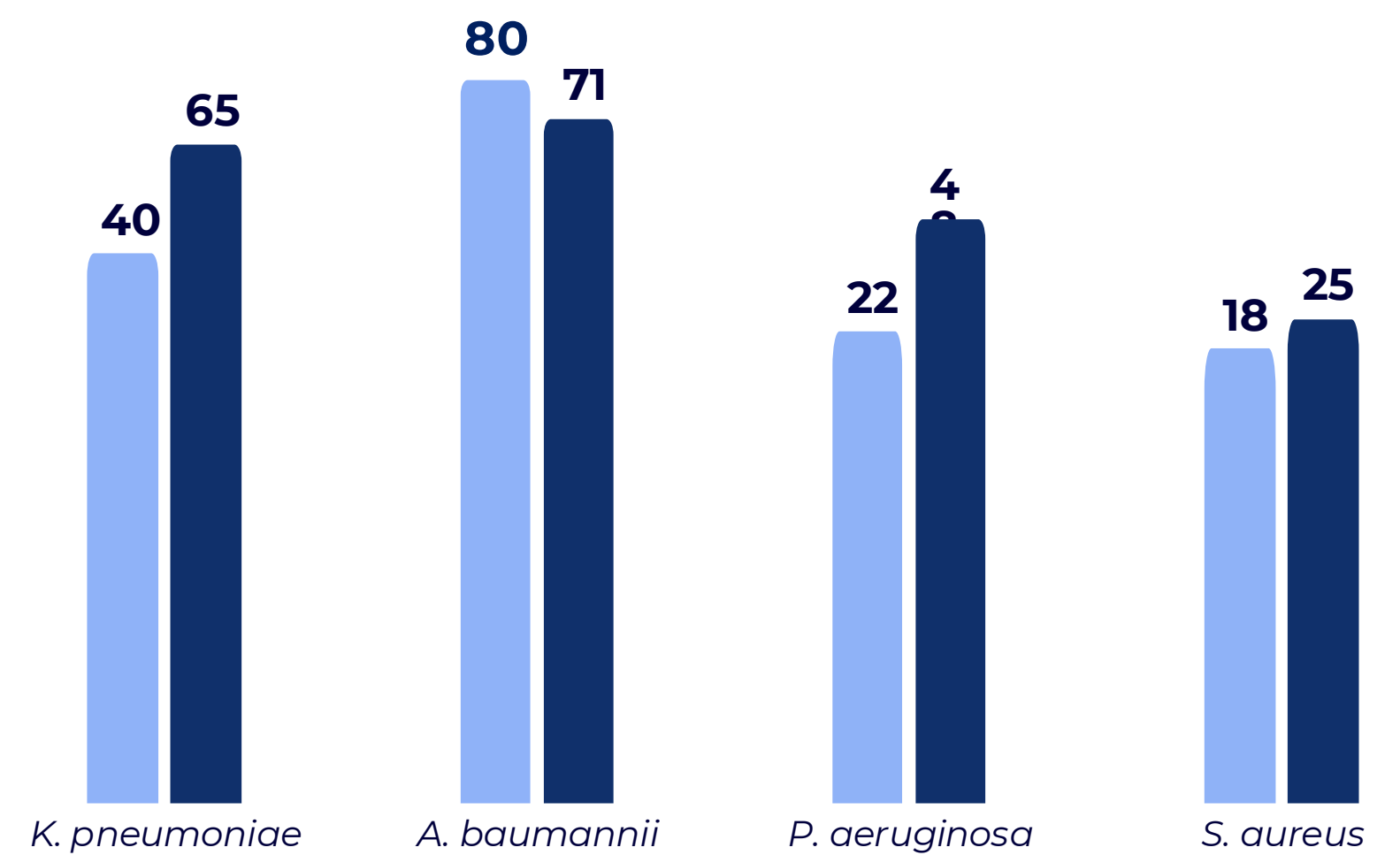
■ *K. pneumoniae* ■ *P. aeruginosa* ■ *A. baumannii* ■ *S. aureus*



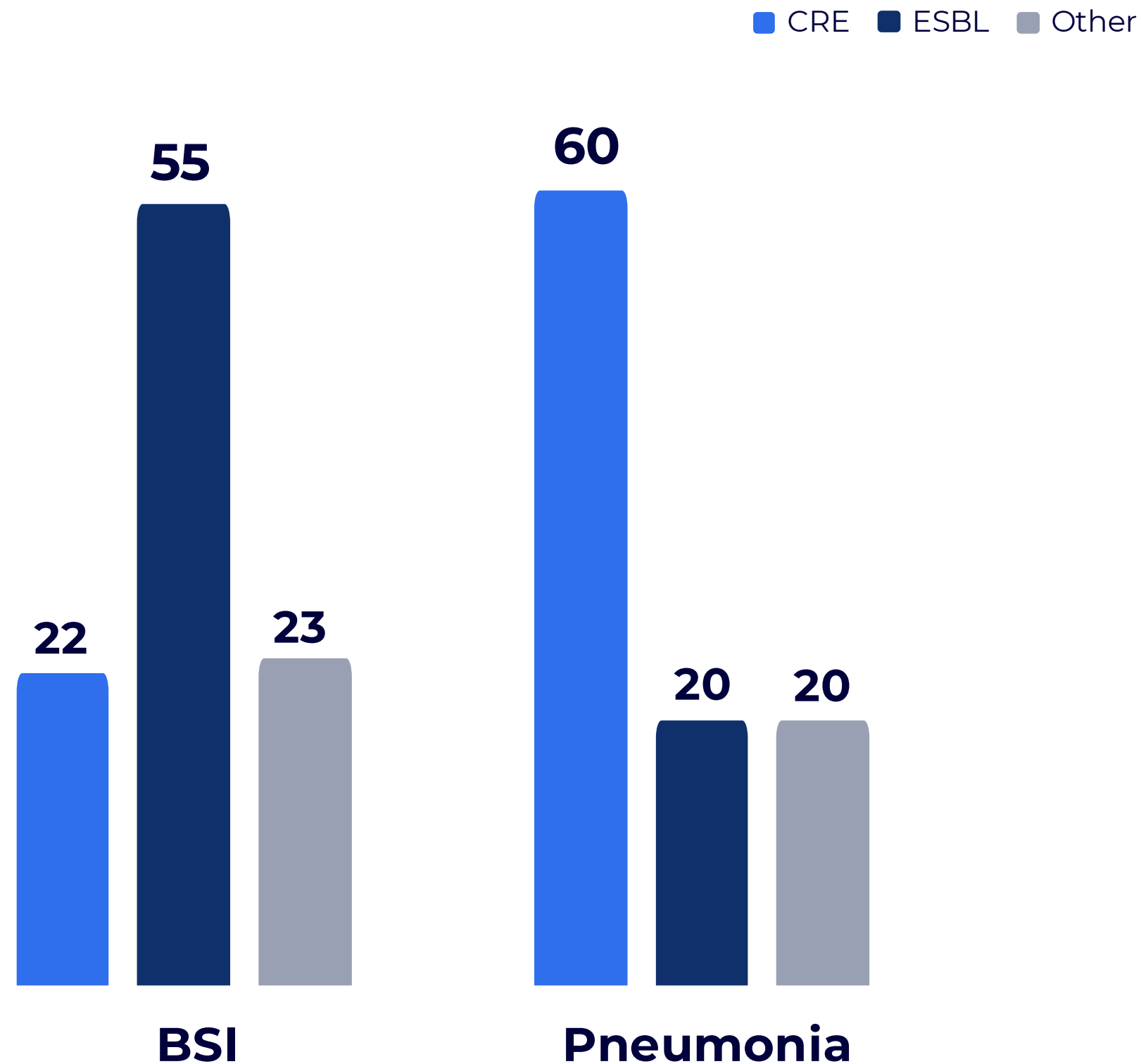
Prevalence of MDR in wounds, Jan–Aug 2025

multidrug-resistant, % prevalence

■ Children ■ Adults



Pathogens causing hospital-acquired infections in adult ICU, 2025



BSI

Includes both clinical sepsis and central-line-associated bloodstream infection.

Pneumonia

Includes both ventilator-associated pneumonia and hospital-acquired pneumonia in patients without prior mechanical ventilation.

Other

Includes gram-positive cocci.

Prevalence of MDR by specimen - blood, urine, sputum

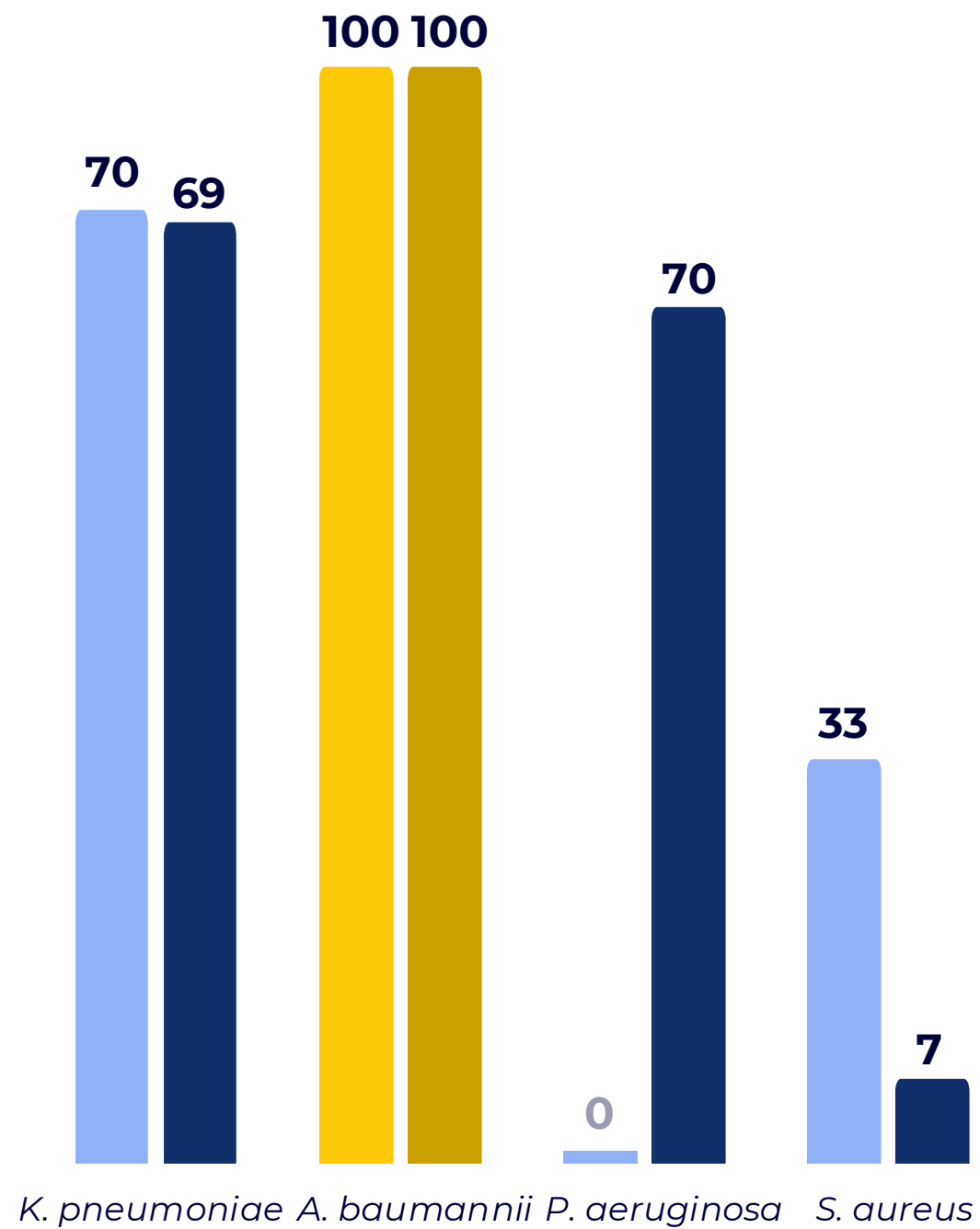


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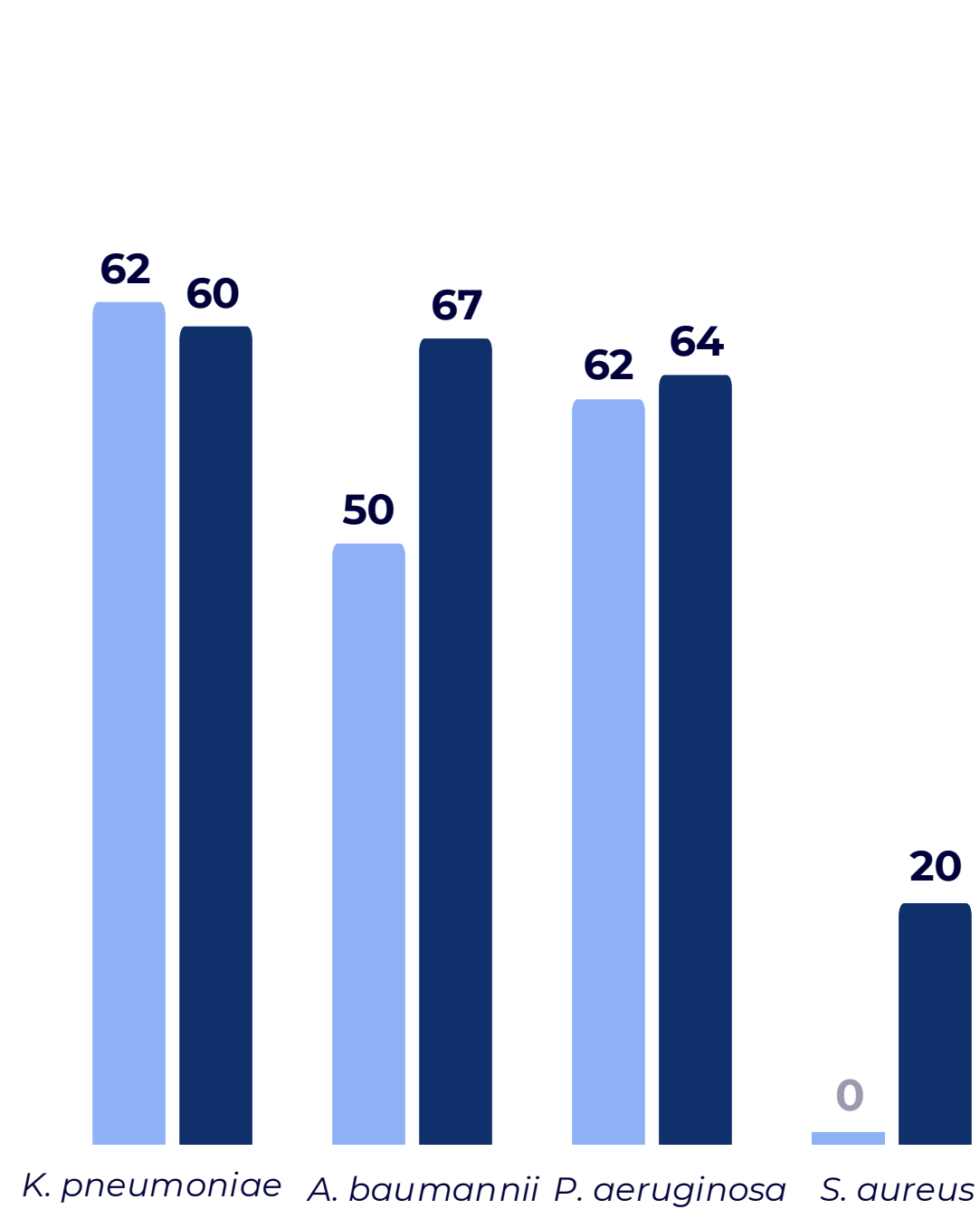
multidrug-resistant, % prevalence · January-August 2025

Children Adults

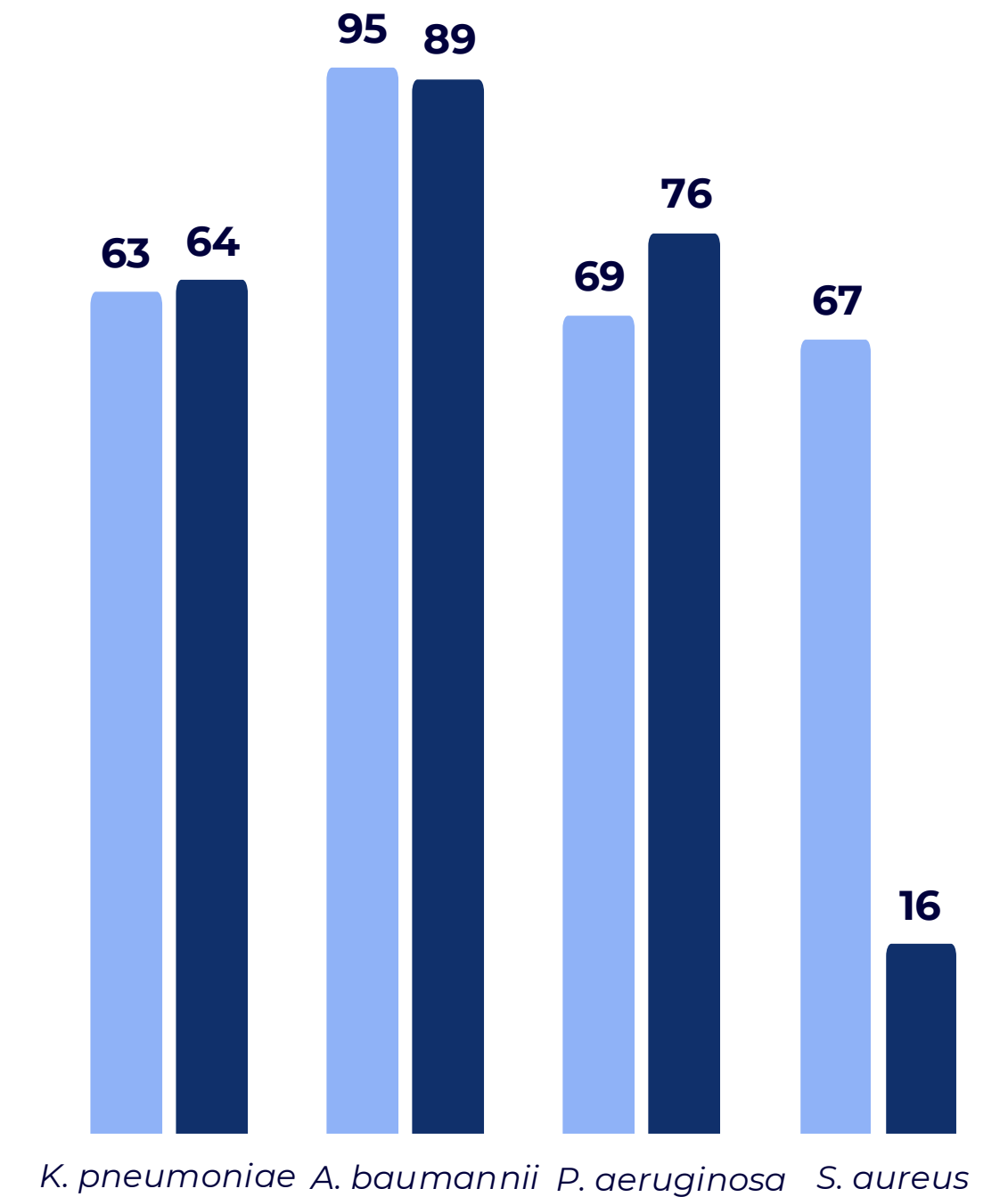
Blood



Urine



Sputum



Updated antibioticogram 2025

Мікроорганізм Organism	№ isolates	MEM Меропенем	IPM Імпіпенем	TMP-SMX Бісептол	AMK Амікацин	GEN Гентаміцин	TOB Тобраміцин	CZA Цефтаз-аві	ATM Азтреонам	COL Колістин
Strep. Group B	131	-	-	23 (10)	-	-	-	-	-	-
S. Group viridans	303	-	-	-	-	-	-	-	-	-
S. pneumoniae	44	-	-	49	-	-	-	-	-	-
A. baumannii	252	18 (11)	16 (6)	17 (2)	19	36	49	-	-	91
Acinetobacter spp.	667	15 (7)	16 (4)	20 (2)	18	38	52	-	-	44
Citrobacter spp.	32	90 (7)	76 (20)	80	93	85	83	100	64 (12)	-
E. cloacae	189	92 (2)	84 (9)	71	93	76	70	94	51 (17)	83
E. coli	614	88 (3)	87 (4)	62 (1)	87	78	75	90	59 (13)	82
K. aerogenes	144	73 (5)	75 (5)	63 (2)	73	69	58	81	44 (11)	-
K. pneumoniae	1015	37 (5)	37 (6)	41 (3)	44	40	32	58	25 (6)	77
M. morganii	34	79 (7)	27 (50)	29	68	58	69	54	80 (5)	0
P. mirabilis	192	78 (10)	43 (33)	22	46	34	32	84	38 (18)	0
P. stuartii	39	43 (34)	30 (13)	14	19	11	15	27	52 (38)	0
P. aeruginosa	486	38 (9)	0 (31)	-	46	-	38	54	0 (56)	68
Pseudomonas spp.	69	41 (14)	2 (47)	-	58	-	14	50	0 (28)	72

Грамнегативні бактерії
Gram negative bacteria

Combat trauma extends beyond Ukraine

AMR in Ukrainian Patients and War-Wound Isolates Across Europe

~7,000 patients treated & rehabilitated in 33 countries via the Medevac Ukraine programme

NETHERLANDS **60% NDM**
58 patients · 75 MDRO isolates

GERMANY **65% MDRO**
17 patients · Ø166-day stay · 71% last-line

FINLAND **78.6% MDR**
166 patients screened

SWEDEN **215 samples**
pandrug resistance · 83 genomes (WGS)

Zwittink et al., *Euro Surveill* 2022;27(50):2200896 (NL) · German war-wound case series · Finnish screening cohort · Karolinska & Lund/Skåne WGS study (SE) · Medevac Ukraine, European Commission.



→ Countries with published AMR studies
... Wider Medevac transfers - 33 countries

Current challenges



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1 Education

Limited AMR, microbiology and stewardship training. No standardized national treatment guidelines.

2 Surveillance

Limited genomic surveillance. Whole genome sequencing not routinely available. Difficult outbreak detection.

3 Diagnostics

Slow microbiological diagnostics. Limited rapid molecular testing. Delayed targeted therapy.

4 Access to antibiotics

Limited access to reserve antibiotics. High treatment costs. Inappropriate pre-hospital antibiotic use.

5 Infection prevention

Limited isolation capacity. Staff shortages. High patient burden.

6 Data integration

Clinical, microbiology and antibiotic data remain fragmented. Limited real-time analytics.

We cannot wait until every systemic problem is solved at national level.

Complex clinical decisions

Multidisciplinary case reviews for hard-to-treat infections - clinicians, ID, microbiology, pharmacy and infection control assessing treatment, source control and transmission together.

Artificial intelligence

CartaNova

Not to replace the physician - to help faster: systematise data, weigh infection probability, review antibiotic therapy. In development.

Education & competency

Charité

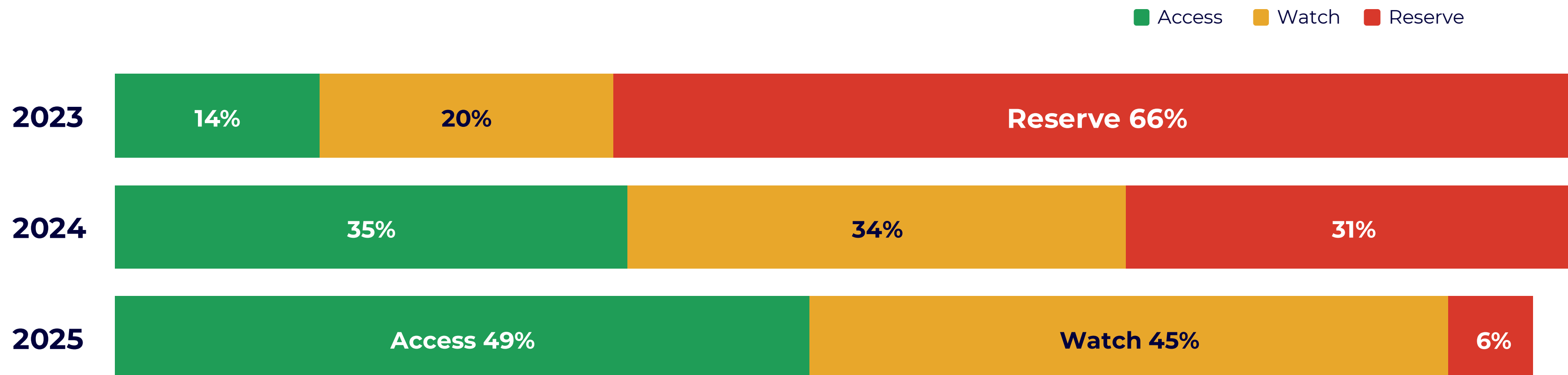
Infection-control training within the UNBROKEN School of Medicine, with a certificate of specialisation - from isolated trainings to systematic preparation.

Microbiological diagnostics

Charité

Even a preliminary blood-culture result, sent earlier, can change treatment before the final report.

Consumption of antibiotics at the First Lviv Territorial Medical Union



Reserve consumption 66% → 31% → 6% an eleven-fold fall in two years

WHAT THIS TELLS US



- 01 War fundamentally changes AMR ecology.
- 02 Prolonged evacuation influences resistance.
- 03 Antimicrobial stewardship becomes even more important during war.
- 04 Microbiology becomes part of trauma care - not laboratory support.**



We still do not know...

- ...how microbiology evolves during rehabilitation.
- ...how chronic combat wounds change over time.
- ...whether regenerative medicine influences bacterial ecology.
- ...which patients benefit most from cell therapy.

That is why we conduct research.

Research output - UNBROKEN Ukrainian Research Centre



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Journal of Antimicrobial Chemotherapy · 2026

participating centre

The burden of war-related infections in Ukraine: a nationwide multicentre cohort study.

DOI 10.1093/jac/dkag115

Journal of Trauma & Acute Care Surgery · 2025

Centre affiliation

Conflict-zone medical evacuations catalyzing antimicrobial resistance spread and threatening regional health.

DOI 10.1097/TA.0000000000004729

The Lancet Infectious Diseases · 2025

institutional data

Cumulative antibiogram results of **over 6,800** diagnostic isolates from the First Lviv TMU, Ukraine.

DOI 10.1016/S1473-3099(25)00116-1

Prehospital & Disaster Medicine · 2025

WADeM abstract

Implementing an infectious disease and antimicrobial stewardship programme for hospital-acquired infections in conflict casualties.

DOI 10.1017/S1049023X25001281

Vector-Borne & Zoonotic Diseases · 2023

clinical case

A single clinical case of leptospirosis in a 70-year-old man during the military conflict in Ukraine.

DOI 10.1089/vbz.2023.0007

Correspondence

submitted

Europe: strengthening AMR resilience through coordinated system-level action - lessons from Ukraine.

Awaiting editorial decision

Combat Trauma Registry Project

OBJECTIVE

A standardized retrospective trauma database from hospital medical records, to support clinical research, quality improvement and evidence-based trauma care.

DATA COLLECTION

Retrospective review of medical records, with standardized data extraction and coding.

DATABASE VARIABLES

Demographics: age, sex.

Admission: vital signs.

Clinical management: invasive procedures.

Evacuation: stages of medical evacuation.

Injury: mechanism of injury.

Anatomical injuries: coding by region & organ.

Microbiology: complications & pathogens.
Etc.

EXPECTED IMPACT

- Comprehensive trauma registry
- Epidemiological & clinical outcome analysis
- Predictors of complications
- Support for research & publications
- Continuous improvement of trauma care

■ ARROW - wound-infection cohort study



5 civilian hospitals across Ukraine

- **Prospective longitudinal cohort study**
- **Hospitalized adult patients with traumatic wounds**
- **Sample size: 1 000 patients total**
- **Duration: 1.5 years of data collection**

Antimicrobial **R**esistance **R**esearch to Improve **O**utcomes of Traumatic **W**ounds

OBJECTIVES

- 1** Describe the antimicrobial status of conflict-associated wound infections in Ukraine, and resistance in managing traumatic wound infections during large-scale combat operations.
- 2** Provide data from ARROW - an observational, prospective cohort.
- 3** Introduce the design and intended benefits of the **PACT-ARROW** protocol for studying wound care in a wartime environment in Ukraine.
- 4** Describe how these data inform future interventions for traumatic wound infections in the country.





agenT-797 in severe hypoxemic pneumonia

PHASE 2B/3 • TRIAL DESIGN

DESIGN

Part 1: unblinded (n=20); Part 2: randomized, double-blind, placebo-controlled

PHASE

2b/3 adaptive (n=80 → n=300)

POPULATION

Severe CAP / ARDS / fungal pneumonia • P/F <200 mmHg

ARMS

agenT-797 + SOC vs. placebo + SOC (1:1)

PRIMARY

28-day all-cause mortality (superiority)

SECONDARY

VFDs, vasopressor-free days, ICU-free days, SOFA trajectories, pathogen clearance

INTERIM

n=40: adaptive re-estimation; BTD if >10% absolute mortality reduction

PATH

BTD → Phase 3 → BLA • target filing 2028



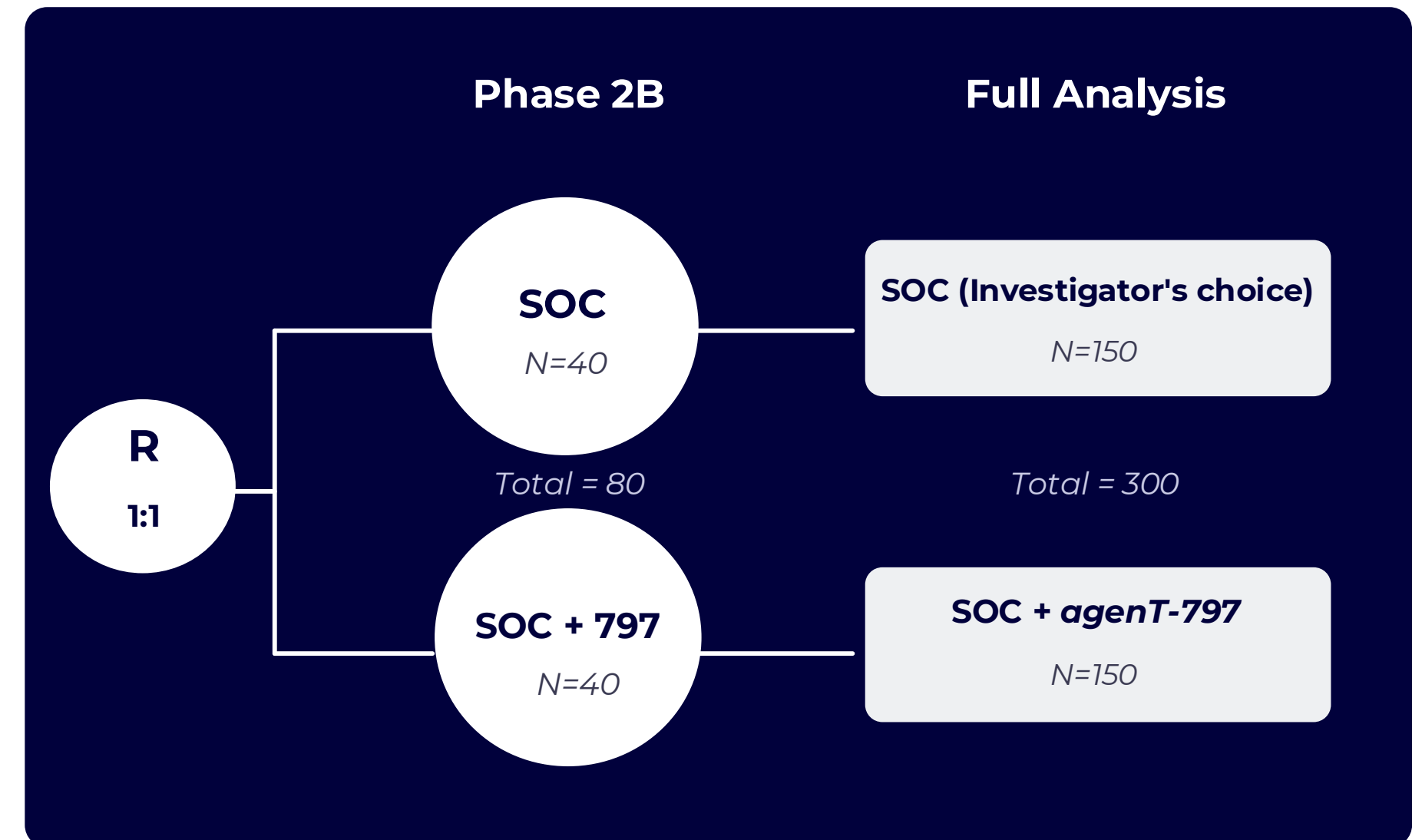
3

patients already enrolled

Results: 6 Aug 2026

NCT07615010

Study C-1300-02



Scientific Advisory Board

World leaders in critical illness & trauma



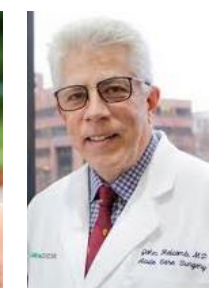
Michael Matthay



Michael Harhay



Shibani Pati



John Holcomb



Terese Hammond

Phage therapy study

UNITED KINGDOM

When meropenem holds against only 18–38% of isolates, non-antibiotic therapeutics stop being exotic - they become necessary.

-  Characterise the mechanisms of resistance in pathogens causing acute and chronic soft-tissue infections.
 -  On that basis, evaluate the efficacy of phage preparations in complex, **difficult-to-treat infections**.
-



War has raised questions that no single hospital can answer alone

In this room are **clinicians, microbiologists, infectious disease specialists, epidemiologists and researchers** whose expertise can turn frontline observations into global evidence.

We invite you to collaborate with us to better understand:

- how antimicrobial resistance evolves during prolonged armed conflict
- how treatment for wounded patients can be improved
- how, together, we can generate evidence for military and civilian medicine worldwide

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**Antimicrobial resistance does
not stop at national borders –
and neither should scientific
collaboration.**



FIRST LVIV TERRITORIAL MEDICAL UNION