

Shock and Whole Blood

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Prehospital Whole Blood (pWB) Administration

- **Review:**

- Reverse shock physiology = improve patient outcomes
- EAST PMG for WB (civilian) = conditional recommendation as no survival advantage but pWB not included
- Study with pWB and military = dec mortality early and 24-hr period
- Advantages of WB over CT
 - 1u WB = 500 mL; 2u WB = replace 20% blood volume (70kg)
 - *Possible Improved early and later survival*
 - ↓ donor exposures, bacterial contamination
 - Provides cold stored plt with impvd hemostatic fxn
- Cost comparison WB vs CT

Study	Duration	Type of Study	Findings	Cost Savings
Ciaraglia et al. ⁴⁹	2016–2021	Single center, Level I	17.3% reduction in annual blood product costs after WB adoption; significant reductions in FFP (51.9%) and platelets (33.1%)	\$927,000 annual net savings
Murphy et al. ⁵⁰	2017–2021	Single center, community trauma center	WB saved a total of \$3.39 M over 5 y. Simplified logistics, reduced MTP activation, prepared products, transfused volumes, and product waste were reported.	\$850,000 average annual savings

Ghaedi A.,Hosseinpour H.,Spencer A.L.,Hejazi O.,Nelson A.,Khurshid M.H.,Al Ma'ani M.,Diaz F.C.,Magnotti L.J. and Joseph B. Prehospital whole blood use in civilian trauma care: A review of current evidence and practices
Journal of Trauma and Acute Care Surgery volume 99 issue 2 pages 310-317 August 2025 (First published: 4/14/2025)
DOI: 10.1097/TA.0000000000004562

TABLE 4 Key outcomes.

Study	Mortality outcome (time point)	Transfusion/resource utilization
Williams et al. ⁴⁷	30-day survival 73% versus 74%; aOR 2.19 (95% CI 1.01–4.76), $p = .047$.	Post-ED blood-product use lower (median 0 vs. 3 units, $p = .001$); aOR 0.47 (95% CI 0.23–0.94, $p = .033$).
Braverman et al. ⁴⁸	ED mortality 0% versus 7.1% ($p = .04$); 6 h 5.3% versus 14.1% ($p = .08$); 24 h 17.2% versus 23.1% ($p = .36$); hospital 13.8% versus 25.0% ($p = .08$).	Greater improvement in shock index ($\Delta SI -0.38$ vs. -0.18 , $p = .004$) in propensity-matched cohort; reduced MTP activation (30.8% vs. 42.2%, $p = .03$).
Brill et al. ⁴⁹	30-day survival 75% versus 76%; unweighted OR 4.10 (95% CI 2.22–7.45, $p < .001$); weighted OR 1.59 (95% CI 1.28–1.98, $p < .001$).	24-h blood-product use reduced by 60%; aOR 0.38 (95% CI 0.21–0.70, $p < .001$); lower total transfusion volume ($p < .001$).
Guyette et al. ⁵⁰	3 h mortality 10.0% versus 10.9%; 6 h 12.5% versus 13.0%; 24 h 15.0% versus 17.4%; 28 d 25.0% versus 26.1% (all $p > .05$).	6-h pRBC use 0 versus 2 units ($p < .01$); 24-h 0.5 versus 2 units ($p < .01$).
Braverman et al. ⁵¹	ED mortality 2.3% versus 4.5% ($p = .18$); 24 h 12.9% versus 16.1% ($p = .27$); hospital 18.7% versus 23.7% ($p = .14$).	MTP activation 22.6% versus 32.4% ($p = .01$); $\Delta SI -0.04$ versus $+0.05$ ($p = .002$); fewer pRBC/FFP/platelet units used.
Sperry et al. ⁵²	4 h RR 0.90 (95% CI 0.59–1.39); 24 h RR 1.08 (0.77–1.52); 28 days RR 1.10 (0.83–1.47); high-risk ($\geq 5\%$ pred. mortality) 4 h RR 0.52 (0.32–0.87).	Total transfusion volume median 12 [4–27] versus 10 [4–22] ($p = .07$). Similar total units ($p = .07$), but higher total volume in mL with LTOWB ($p < .001$).
Kostolnı et al. ⁵³	Adjusted OR 1.7 (95% CI 0.6–4.9); trauma mortality 16.0% versus 7.3% ($p = .358$); non-trauma 22.2% versus 9.0% ($p = .615$).	$\Delta SI -0.20$ versus -0.30 ($p = .04$); minor differences in IIR and SBP; no mortality difference in sensitivity analyses.

Review: pWB Administration

Endpoint	Study	Prehospital WB vs comparator	Statistical result
ED mortality	Braverman et al.	0% vs 7.1%	$p = .04$
4-hour mortality	Sperry et al.	RR 0.90 (95% CI 0.59–1.39)	CI crosses 1
6-hour mortality	Braverman et al.	5.3% vs 14.1%	$p = .08$
6-hour mortality	Guyette et al.	12.5% vs 13.0%	$p = .94$

Dion P-M, Greene A, Aves T, Pan A, Drennan I, von Vopelius-Feldt J, et al. Prehospital whole blood transfusion in hemorrhagic shock: A systematic review. **Transfusion**. 2026; 66(Suppl. 1): S376–S390. <https://doi-org.oh.idm.oclc.org/10.1111/trf.70146>

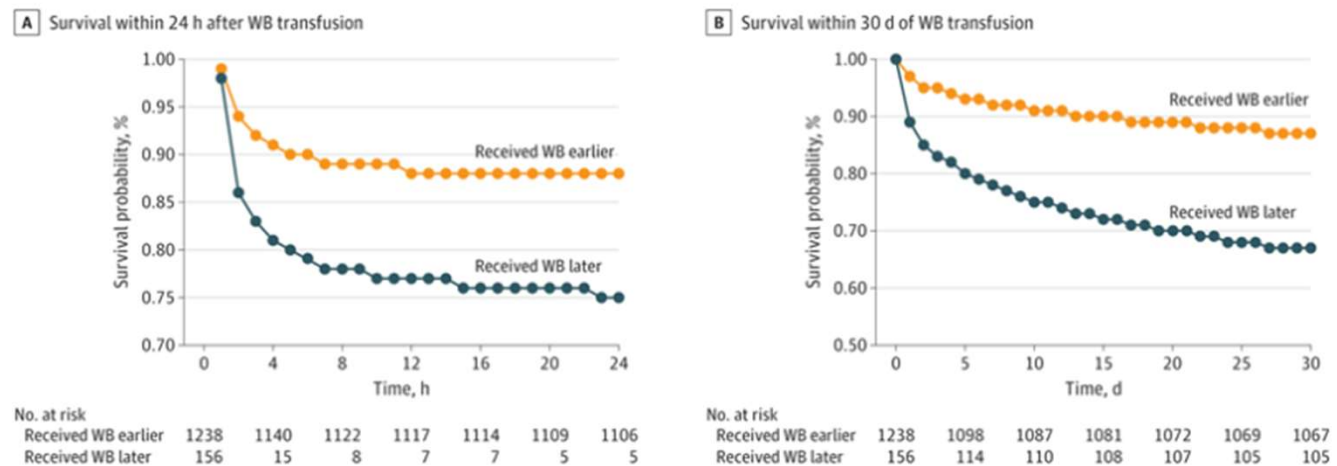
- R-cohort study using harmonized database of 6 trials using pCT
 - Primary: 24-hr mortality: no sig difference
 - Secondary:
 - 28-d mortality: no sig difference x when early mortality
 - ICU-free days - varied
 - MV-free days - varied
 - **ALL incidence – dec with every 10% inc in PH:Total blood ratio**

Furman, L. , Feeney, E. , Bizri, N. , Mitra, B. , Gruen, R. , Medcalf, R. , Gaines, B. , Guyette, F. , Moore, E. , Holcomb, J. , Sperry, J. & Leeper, C. (2026). Increased prehospital to total blood product administration associated with improved hospital outcomes: A secondary analysis of hemorrhagic shock trials. **The Journal of Trauma and Acute Care Surgery**, 101 (1), 39-47. doi: 10.1097/TA.0000000000004970

Timing of first WB Tx and Survival

- Time is life: Improved survival at 24 hrs for earlier WB tx compared to later (time-varying exposure)
- ↓ est prob of survival if time to WB tx was after **14 min** of ED arrival
- Survival at 4 hrs – for every 1-min ↑ in time to WB tx = assoc ↑ risk mortality

Figure. Standard Survival Curves of Whole Blood (WB) Transfusion Timing



Estimated survival probability of patients who received WB as an adjunct to the component-based massive transfusion protocol earlier vs later during the first 24 hours after emergency department arrival. Every patient received WB.

Torres C.M.[3],Kenzik K.M.[3],Saillant N.N.[3],Scantling D.R.[3],Sanchez S.E.[3],Brahmbhatt T.S.[3],Dechert T.A.[3],Sakran J.V.[5],Torres C.[2],Kenzik K.[2],Saillant N.[2],Scantling D.[2],Sanchez S.[2],Brahmbhatt T.[2],Dechert T.[2] and Sakran J Timing to First Whole Blood Transfusion and Survival Following Severe Hemorrhage in Trauma Patients. **JAMA Surgery** volume 159 issue 4 pages 374-381 4/1/2024 DOI: 10.1001/jamasurg.2023.7178 PMID: 38294820

pWB and WB

- **SWiFT Trial Group**
 - pWB tx of 2u in life-threatening hemorrhage ≠ superior to standard care (CT) for risk of death/MTP within 24 hrs
- **TOWAR Study Group**
 - pWB in trauma hemorrhagic shock pts ≠ ↓ 30-d mortality compared to CT
- **SWAT Study Group**
 - WB Pts with ↑ prob of mortality, 48% lower risk of 4-hr and 30% lower risk of 28-d mortality

Jason E. Smith, M.D., Rebecca Cardigan, Ph.D., Emily Sanderson, M.Sc., Laura Silsby, B.Sc., Claire Rourke, M.Sc., Ed B.G. Barnard, Ph.D. Peter Basham, B.Sc., +18 , for the SWiFT Trial Group. Prehospital Whole Blood in Traumatic Hemorrhage — A Randomized Controlled Trial. March 17, 2026. **N Engl J Med** 2026;394:2305-2316. DOI: 10.1056/NEJMoA2516043.

Jason L. Sperry, M.D., M.P.H., Francis X. Guyette, M.D., M.P.H., Bryan A. Cotton, M.D., James F. Luther, M.A., Richard B. Utarnachitt, M.D., Matthew E. Kutcher, M.D. Brian J. Daley, M.D., +24 , for the TOWAR Study Group*. Prehospital Resuscitation with Type O Whole Blood for Trauma and Hemorrhage. May 18, 2026. **N Engl J Med** 2026;394:2317-2328. DOI: 10.1056/NEJMoA2602167.

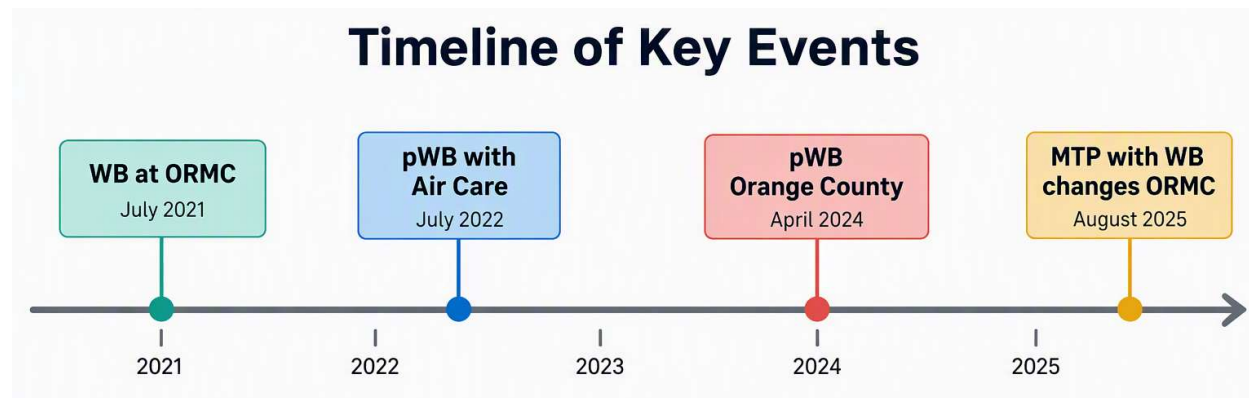
Sperry JL, Cotton BA, Luther JF, et al; Whole Blood, and Assessment of Traumatic Brain Injury (SWAT) Study Group. Whole blood resuscitation and association with survival in injured patients with an elevated probability of mortality. **J Am Coll Surg** 2023;237:206–19.

	PH Blood (n = 879)	No PH Blood (n = 211)	p
Scene heart rate, bpm	114 (94, 134)	110 (84, 122)	0.005
Scene SBP, mm Hg	96 (76, 122)	105 (84, 128)	0.047
Scene respiratory rate, per min	20 (16, 25)	20 (16, 24)	0.733
Scene GCS	9 (3, 15)	14 (6, 15)	<0.001
Scene Shock Index	1.14 (0.86, 1.53)	1.00 (0.79, 1.36)	0.013
Dispatch time to ED arrival, min	47 (39, 58)	29 (24, 37)	<0.001
Scene arrival to ED arrival, min	31 (24, 39)	21 (17, 29)	<0.001
ED heart rate, bpm	108 (88, 128)	114 (92, 128)	0.106
ED SBP, mmHg	102 (86, 124)	111 (87, 136)	0.021
ED GCS	3 (3, 15)	14 (3, 15)	<0.001
ED temp, C	36.7 (36.1, 37.0)	36.4 (36.2, 36.8)	0.007
ED Shock Index	1.01 (0.81, 1.31)	0.99 (0.80, 1.26)	0.522
Delta SI (Scene SI-ED SI)	0.10 (-0.14, 0.40)	0.018 (-0.24, 0.27)	0.019

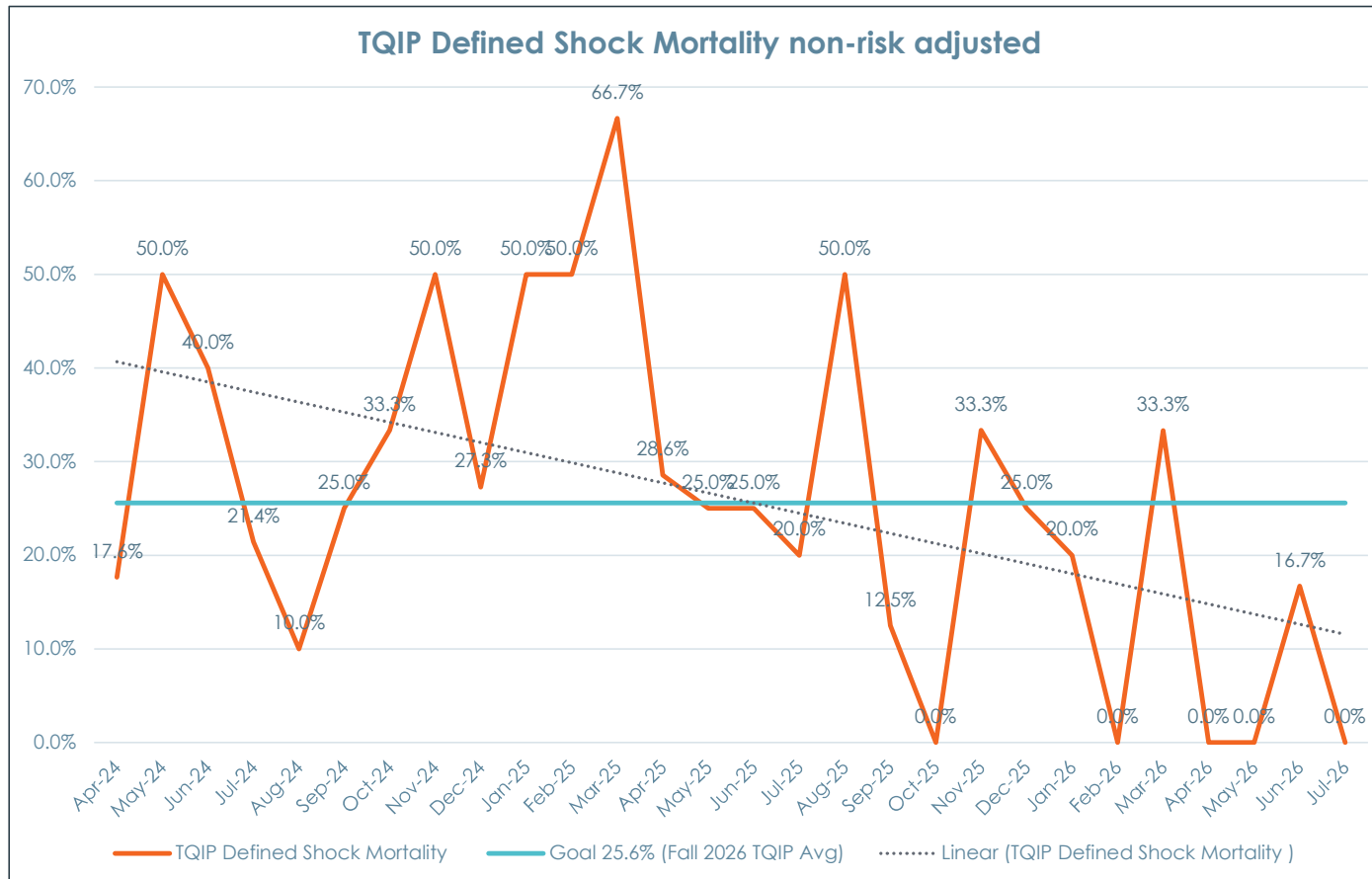
	PH Blood (n = 879)	No PH Blood (n = 211)	p -Value
Acute renal failure	11.3%	5.7%	0.035
Sepsis	24.8%	25.9%	0.770
Pneumonia	19.5%	17.7%	0.588
UTI	4.9%	3.7%	0.539
Acute lung injury	7.2%	2.0%	0.021
30-day survival	77%	75%	0.373
Predicted survival by PH-TRISS	0.70 (0.32, 0.96)	0.94 (0.58, 0.97)	<0.001
Unexpected survivors by PH-TRISS	15%	6%	<0.001
Unexpected deaths by PH-TRISS	7%	20%	<0.001
Predicted survival by ED-TRISS	0.78 (0.32, 0.95)	0.95 (0.82, 0.98)	<0.001
Unexpected survivors by ED-TRISS	17%	9%	0.004
Unexpected deaths by ED-TRISS	6%	14%	0.002

Date periods for reports

- **Spring 2025-** October 2023-September 2024
- **Fall 2025-** April 2024-March 2025
- **Spring 2026-** October 2024-September 2025
- **Fall 2026-** April 2025-March 2026



TQIP Defined Shock Mortality (Fall 2025 TQIP Reporting Period-Present)



12.8%

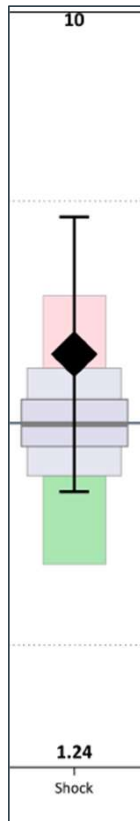
FY26 YTD: 5 deaths / 39 shock patients (Oct-25-Jul-26)

25.6%

Fall 2026 Average

TQIP Risk Adjusted Shock Mortality

Fall
2025
TQIP
Shock



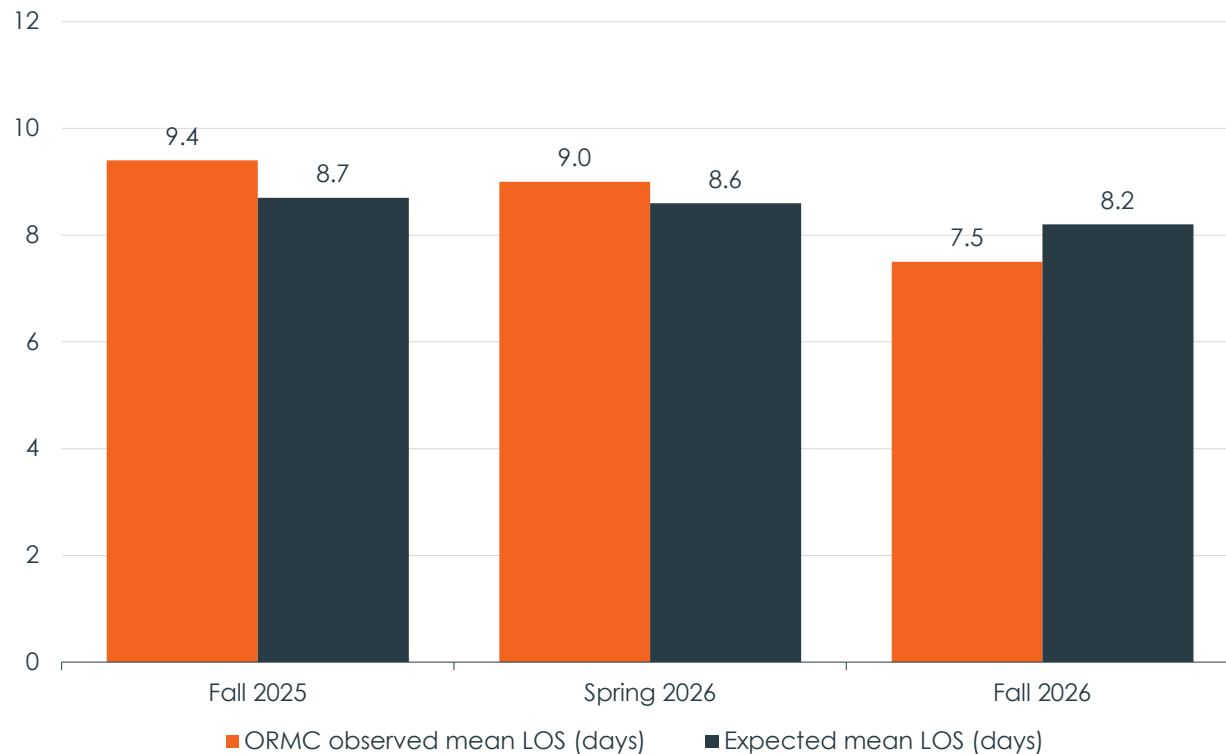
Spring
2026
TQIP
Shock



Fall
2026
TQIP
Shock



Shock LOS is now < expected (ratio 0.70)



1.10 → 0.70

Risk-adjusted LOS ratio, Fall 2025 to
Fall 2026

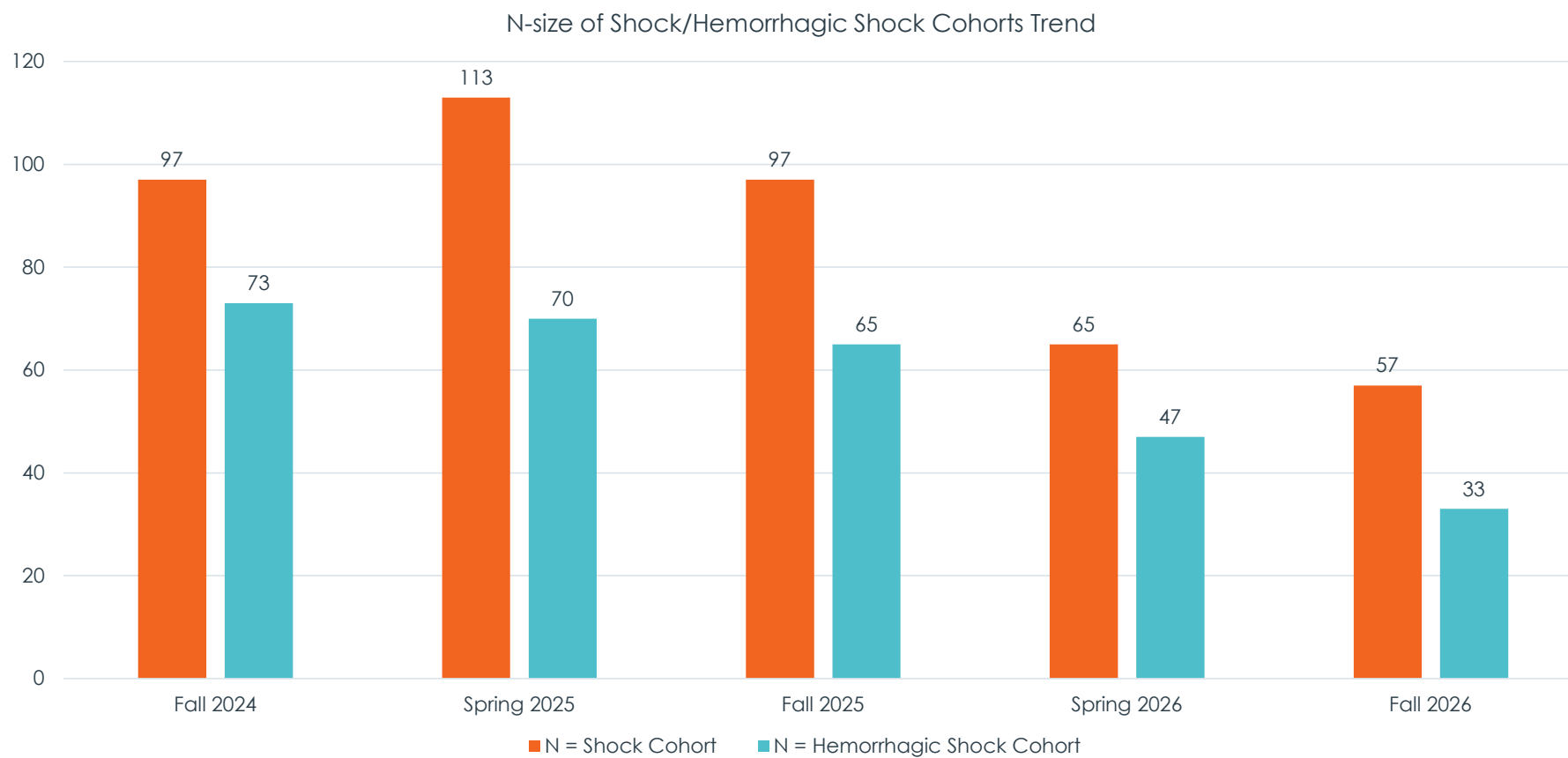
27.4% → 17.4%

Shock patients above TQIP 75th
percentile LOS

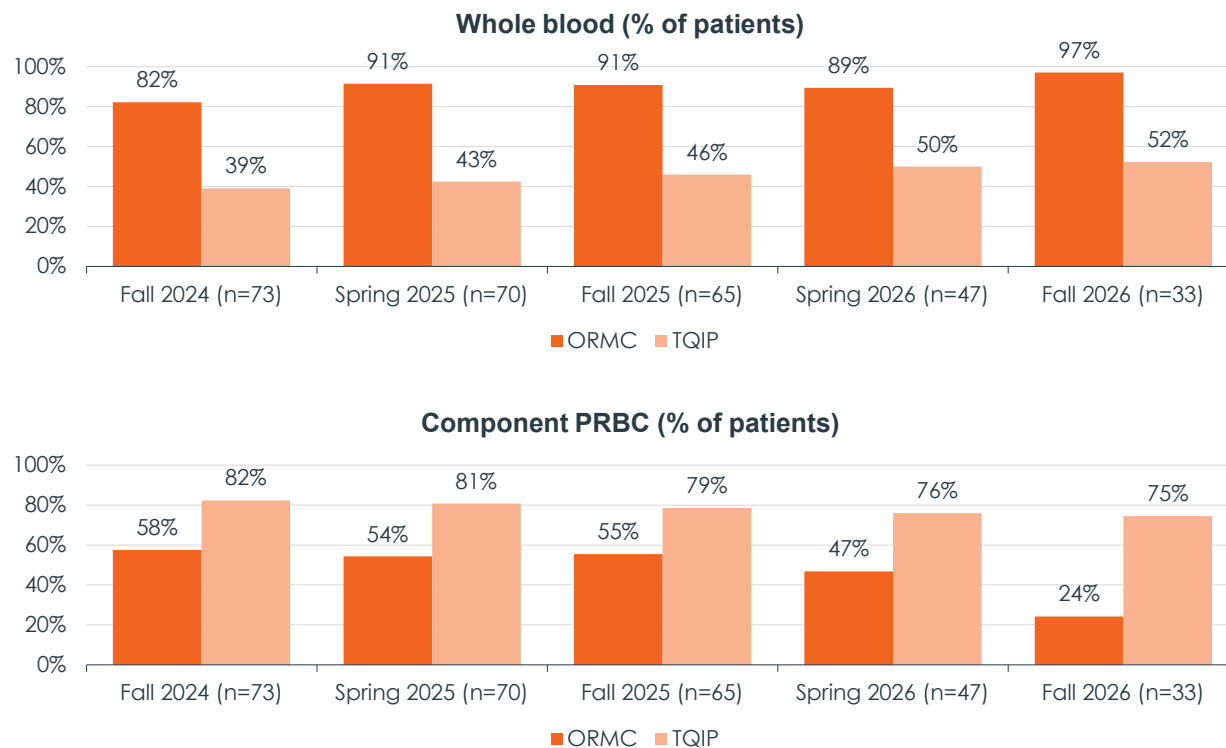
Fall 2026: decile 3, Average outlier
status. Risk-adjusted LOS first reported
Fall 2025.

Source: TQIP Benchmark Reports, Spring 2025–Fall 2026 (ORMC, TQIP ID 163), Risk-Adjusted Length of Stay, Shock cohort.

N-size Trend



Whole Blood vs Component PRBC



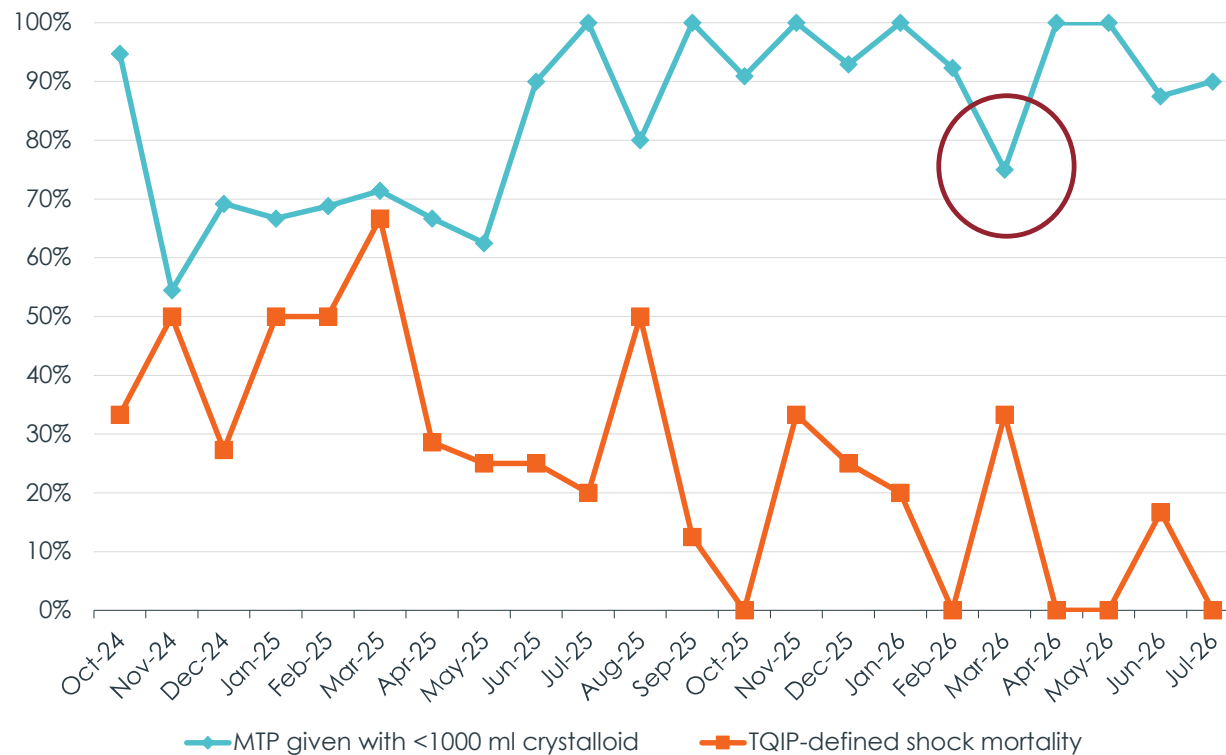
97% vs 52%
Got Whole Blood, Fall 2026 (ORMC vs TQIP)

**Median Whole Blood
2 units
Average increased to
3 units**

Across this time period, WB average utilization increased by 1 unit

Source: TQIP Benchmark Reports, Fall 2024–Fall 2026 (ORMC, TQIP ID 163), Processes of Care: Hemorrhagic Shock Management within First 24 Hours, Table: Transfusion Volume.

Shock mortality fell with ↑WB MTP & ↓crystalloid

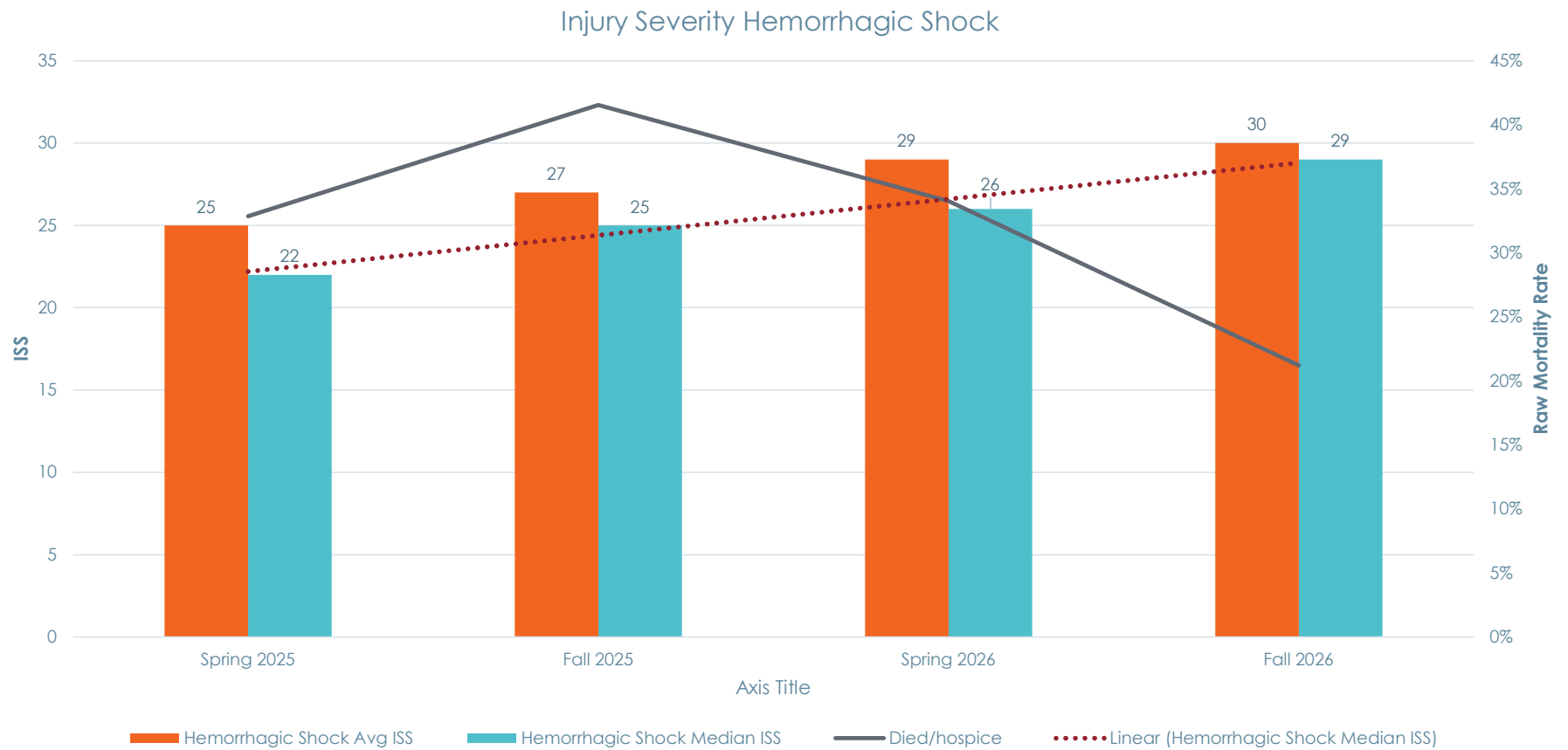


36.5% → 12.8%
Shock mortality, FY25 vs FY26 YTD
(mean monthly)

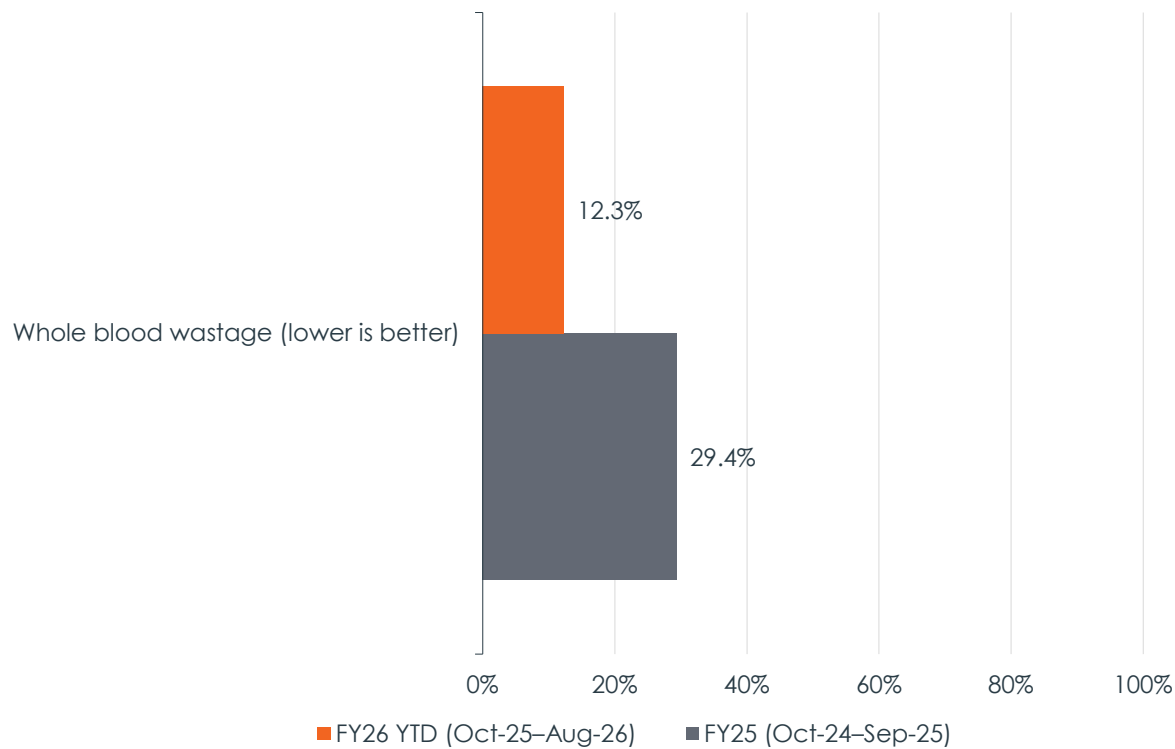
0 of 39
AKI in shock, FY26 YTD

Source: 2025 & 2026 PIPS Calendar and Scorecard, MTP Scorecard (2) and TQIP Defined Mortality tabs, Oct 2024–Jul 2026.

Hemorrhagic Shock Sub-Cohort ISS and Mortality



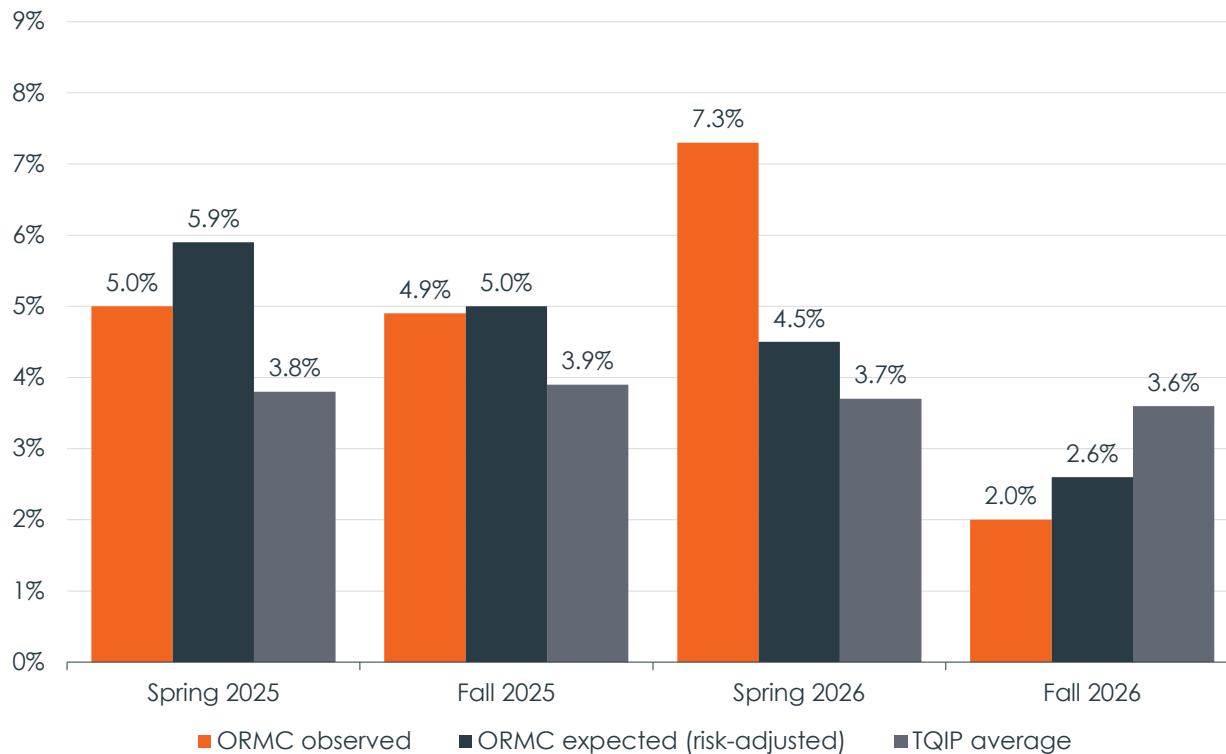
FY26: Increased WB Utilization and Wastage



29.4% → 12.3%
Whole blood wastage (target <10%)

Whole blood use held at 92.7%. MTP activations: 131 in FY25, 119 in FY26.

AKI in shock fell to 2.0%, below expected and TQIP average



1 of 50

Shock patients with AKI, Fall 2026 (OR 0.94)

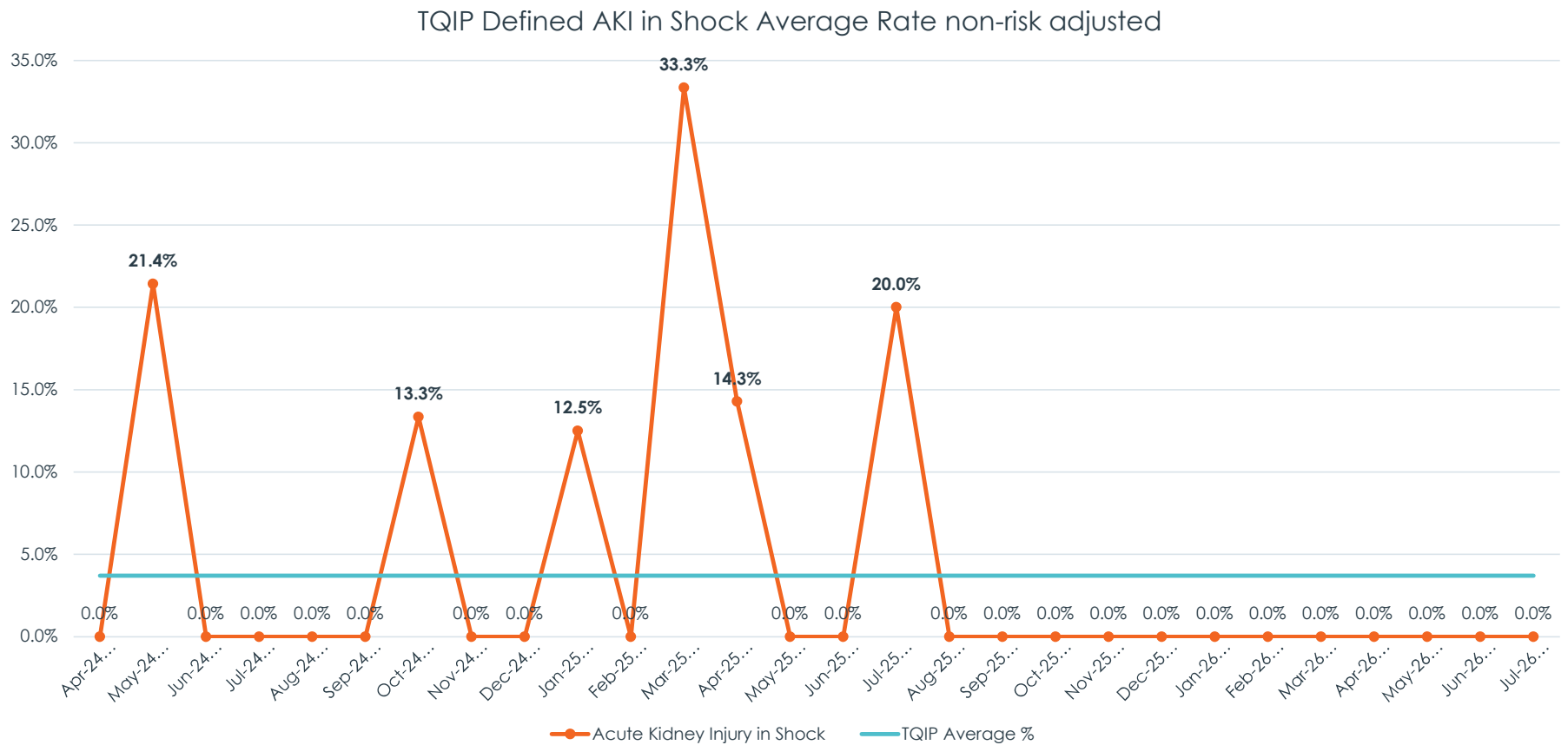
Decile 9 → 4

AKI in shock, Spring 2026 to Fall 2026

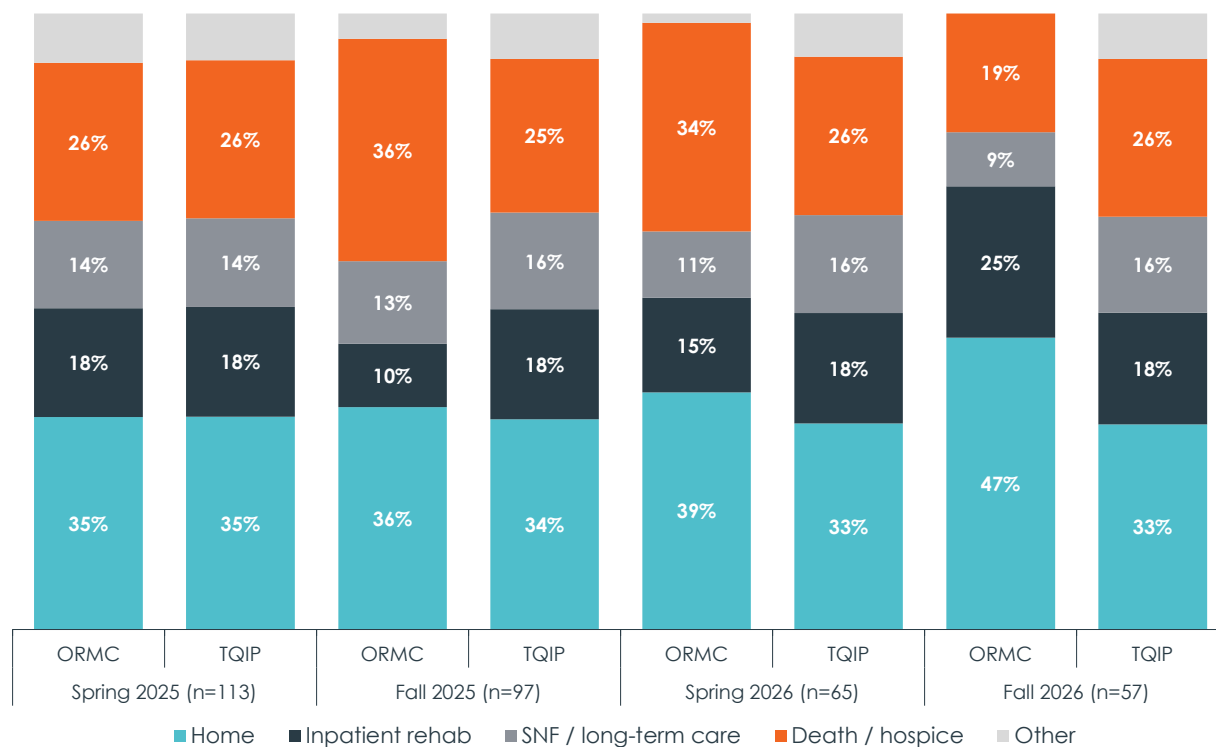
Spring 2026 peak (7.3%, OR 1.21) was 4 events in 55 patients; all reports were Average.

Source: TQIP Benchmark Reports, Spring 2025–Fall 2026 (ORMC, TQIP ID 163), Risk-Adjusted Specific Hospital Events, AKI – Shock cohort.

TQIP Defined AKI in Shock Trends by Month



Discharge Disposition- TQIP Shock cohort



47% vs 33%
Discharged home, Fall 2026 (ORMC vs TQIP)

Source: TQIP Benchmark Reports, Spring 2025–Fall 2026 (ORMC, TQIP ID 163), In-Hospital Events: Discharge Disposition by Cohort, Shock. Death not risk-adjusted.

Discussion Points for Direction following implementation of WB and pWB

- **Hospital events:** AKI in Shock – none in FY 2026 for ORMC; ALI reduction in literature
- **Mortality/Survival:** Shock mortality has steadily decreased; is timing the key?
- **LOS:** Hosp LOS in Shock cohort lower and now under benchmark; literature is mixed with overall Hosp and ICU LOS
- **Cost:** What is financially important: CT products used, OR utilization/stat, MTP activation and use, LOS, CMI ...

QUESTIONS?



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