Which poisoned patients require treatment in the intensive care unit?

External Validation of the INTOXICATE Clinical Decision Rule

Aiden Peleg, Caitlin House, Svetlana Ross, Roland Zemla, MD, PhD,
Michael Chary, MD PhD

Weill Cornell Medicine
Emergency Medicine

Many Acutely Intoxicated Patients Admitted to the ICU do Not Require ICU-Level Care

Utilization of Intensive Care Services, 2011

Marguerite L Barrett, Mark W Smith, Anne Elixhauser, Leah S Honigman, Jesse M Pines

102,000 poisoning admissions without major complications, 57.6% spent time in the ICU.

Emergency department admissions to the intensive care unit – a national retrospective study

Susanne B. Wilhelms ✉ & Daniel B. Wilhelms

Intoxication was the most common reason for ICU admission but had lowest ICU mortality (0.27%)

A quarter of admitted poisoned patients have a mild poisoning and require no treatment: An observational study

Laura Hondebrink [1], Saskia J Rietjens [2], Dirk W Donker [3], Claudine C Hunault [2], Irma van den Hengel-Koot [2], Pauline M Verputten [2], Irma de Vries [2], Karin A H Kaasjager [4], Douwe Dekker [5], Dylan W de Lange [6]

Most intoxicated ED patients were admitted, but many did not require treatment; mortality was 2%

Many Acutely Intoxicated Patients Admitted to the ICU do Not Require ICU-Level Care

Utilization of Intensive Care Services, 2011

Marguerite L Barrett, Mark W Smith, Anne Elixhauser, Leah S Honigman, Jesse M Pines

102,000 poisoning admissions without major complications, 57.6% spent time in the ICU.

Emergency department admissions to the intensive care unit – a national retrospective study

Susanne B. Wilhelms & Daniel B. Wilhelms

Intoxication was the most common reason for ICU admission but had lowest ICU mortality (0.27%)

A quarter of admitted poisoned patients have a mild poisoning and require no treatment: An observational study

Laura Hondebrink [1], Saskia J Rietjens [2], Dirk W Donker [3], Claudine C Hunault [2], Irma van den Hengel-Koot [2], Pauline M Verputten [2], Irma de Vries [2], Karin A H Kaasjager [4], Douwe Dekker [5], Dylan W de Lange [6]

Most intoxicated ED patients were admitted, but many did not require treatment; mortality was 2%

- **Overtreatment**
- **Reduced system capacity for those who need ICU care**
- **Delayed access to psychiatric care**
- **High cost**

Brandenburg's Decision Rule

INTOXICATE Predicts the need for mechanical ventilation or vasopressors within 24 hours of ICU admission ***or*** death at any point during hospital stay

Developed on data from the Dutch **N**ational **I**ntensive **C**are R**e**gistry (NICE) by Brandenburg et al

9,679 ICU admissions → **Linear predictive model** → **Validation (multiple)**

Externally validated by Zwaag et al. (EAPCCT 2023)

The Rule

Risk factors are assigned a ***score*** representing contribution towards absolute risk

- **Age**
- **Heart rate**
- **Systolic BP**
- **GCS**
- **Intoxication type**
  - Alcohol
  - Analgesic
  - Antidepressant
  - Street drug
  - Sedative
  - CO, As, CN
  - Toxin NOS
  - Combination
- **Presence of four comorbidities**

The Rule

Risk factors are assigned a ***score*** representing contribution towards absolute risk

- **Age**
- **Heart rate**
- **Systolic BP**
- **GCS**
- **Intoxication type**
  - Alcohol
  - Analgesic
  - Antidepressant
  - Street drug
  - Sedative
  - CO, As, CN
  - Toxin NOS
  - Combination
- **Presence of four comorbidities**

IRS* ≤6 → INTOXICATE recommends *against* ICU

Brandenburg's Results:

- **Sensitivity:** 93.4%
- **Specificity:** 36.2%

INTOXICATE can potentially *reduce* unnecessary ICU admissions by <u>34.4%</u>

ICU **Requirement **S**core = sum of covariate scores*

Our Study

How does INTOXICATE perform on **ED patients** at a **U.S. medical center?**

- Toxicology consultations between **Jan 2023-Apr 2024**
- **101* patients** aged 30 [18 to 46] years (*median [IQR]*)
  - **18** (18%) admitted to **ICU**
  - **16** (16%) admitted to General Medical Floor (**GMF**)
  - **67** (66%) **discharged** from ED or transferred to psychiatry

**112 consultations, 11 excluded due to incomplete information, age <12 years, or consult for reason other than acute ingestion*

Does INTOXICATE Predict the Need for Pressors, Mechanical Ventilation, or Death?

		ICU Intervention	
		Required	Not Required
INTOXICATE Predicts	Needs ICU	8	38
	Doesn't Need	0	55

No patients who were discharged returned to any hospital in the metropolitan area in 48 hours or died within 30 days of ED encounter.

Statistic	*Value*	*95% CI*
Sensitivity	100%	63.1 - 100%
Specificity	59.1%	48.5 - 69.2%
PPV	17.4%	14.2 - 21.2%
NPV	100%	93.5 - 100%

How Would INTOXICATE Have Performed in Our Cohort?

INTOXICATE correctly identified **5 (28%)** ICU patients who did not require ICU intervention.

How Would INTOXICATE Have Performed in Our Cohort?

INTOXICATE correctly identified **5 (28%)** ICU patients who did not require ICU intervention.

But…

All 5 patients had been admitted based on **hospital policy** (6 total policy admits)

- Monitoring of NAC infusion
- Hyperbaric chamber is in ICU

How Would INTOXICATE Have Performed in Our Cohort?

INTOXICATE correctly identified **5 (28%)** ICU patients who did not require ICU intervention.

But…

All 5 patients had been admitted based on **hospital policy** (6 total policy admits)

- Monitoring of NAC infusion
- Hyperbaric chamber is in ICU

Risk of delayed toxicity is not the only reason for ICU admission.

INTOXICATE recommended ICU for an additional **33 patients** who did not require it.

INTOXICATE Does Not Agree With Bedside Toxicologist's Disposition

		Toxicologist Recommends: Admit to ICU	Toxicologist Recommends: Don't admit to ICU
INTOXICATE Recommends	Admit to ICU	13	33
	Don't admit to ICU	5	50

Total recommended to ICU

- INTOXICATE: 46/101 (46%)
- Toxicologist: 18/101 (18%)

Following **INTOXICATE's** recommendations would have increased ICU admissions **155%**

INTOXICATE Does Not Agree With Bedside Toxicologist's Disposition

		Toxicologist Recommends: Admit to ICU	Toxicologist Recommends: Don't admit to ICU
INTOXICATE Recommends	Admit to ICU	13	33
	Don't admit to ICU	5	50

Total recommended to ICU
- INTOXICATE: 46/101 (46%)
- Toxicologist: 18/101 (18%)

Following **INTOXICATE's** recommendations would have increased ICU admissions **155%**

Inter-rater reliability was only **slight*** indicating different criteria for determining ICU disposition.

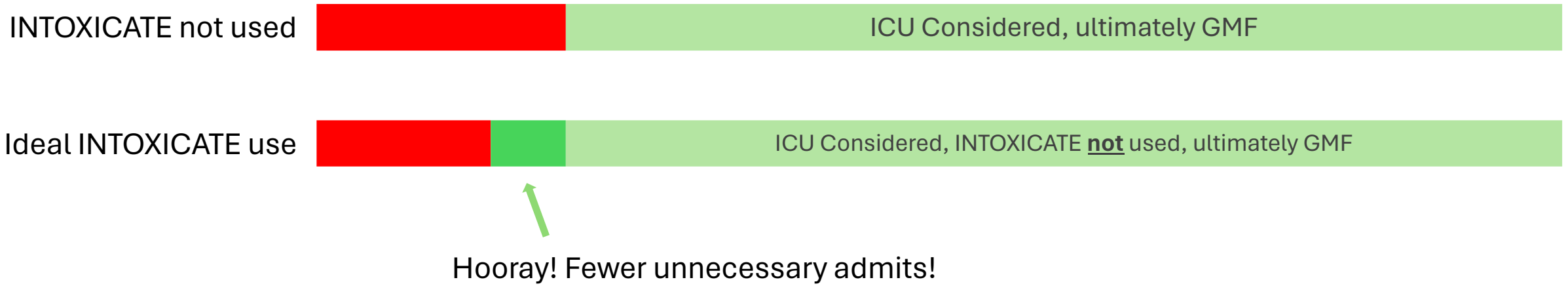
*Cohen's $k = 0.202$, $p = 0.049$

Model Accuracy is Not Enough

Imagine a year of toxicology consults at your hospital…

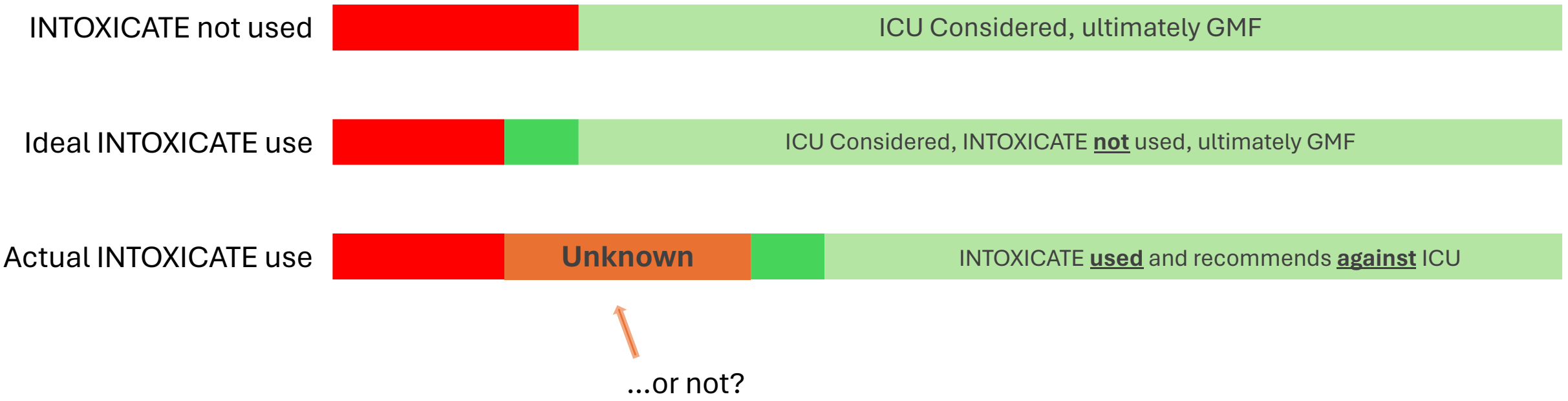
Model Accuracy is Not Enough

Imagine a year of toxicology consults at your hospital…



Model Accuracy is Not Enough

Imagine a year of toxicology consults at your hospital…



Conclusion

- *Statistically*, **INTOXICATE** is sensitive but not specific in predicting ICU requirement
- *Clinically*, **INTOXICATE** overestimates ICU need in patients who would not have otherwise been admitted to the ICU
- INTOXICATE generally does not agree with bedside toxicologist's disposition
- Low specificity complicates the benefit of prognostication in the ED

Next Steps

- Evaluate INTOXICATE performance in a multi-site sample excluding certain poisonings (salicylate, alcohol, etc.)
- Consider clinical pathway that uses
  - **Poison-specific pathways when possible** (e.g., acetaminophen)
  - INTOXICATE for undifferentiated poisonings.
  - Accounts for regional variation in poisoning and policy (ICU vs floor for NAC or diazepam infusions)

Acknowledgements

The Chary Lab

- Michael Chary, MD PhD
- Roland Zemla, MD PhD
- Caitlin House
- Svetlana Ross
- Ali Abdelati, MD

WCM Administration

- Rahul Sharma, MD, MBA
- Junaid Razzak, DrPH, MBBS
- Judy Porembra

New York Medical College

NACCT

Weill Cornell Medicine
Emergency Medicine