2018

Impact of clinical guideline implementation of adult ketamine dosing in the emergency department

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Impact of Clinical Guideline Implementation of Adult Ketamine Dosing in the Emergency Department

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The speaker has no actual or potential conflict of interest in relation to this presentation.

Ketamine Indications

Food and Drug Administration (FDA) Labeled Indication

- Sedation

Off-Label Indications

- Analgesia
- Procedural sedation
- Excited delirium
- Status asthmaticus

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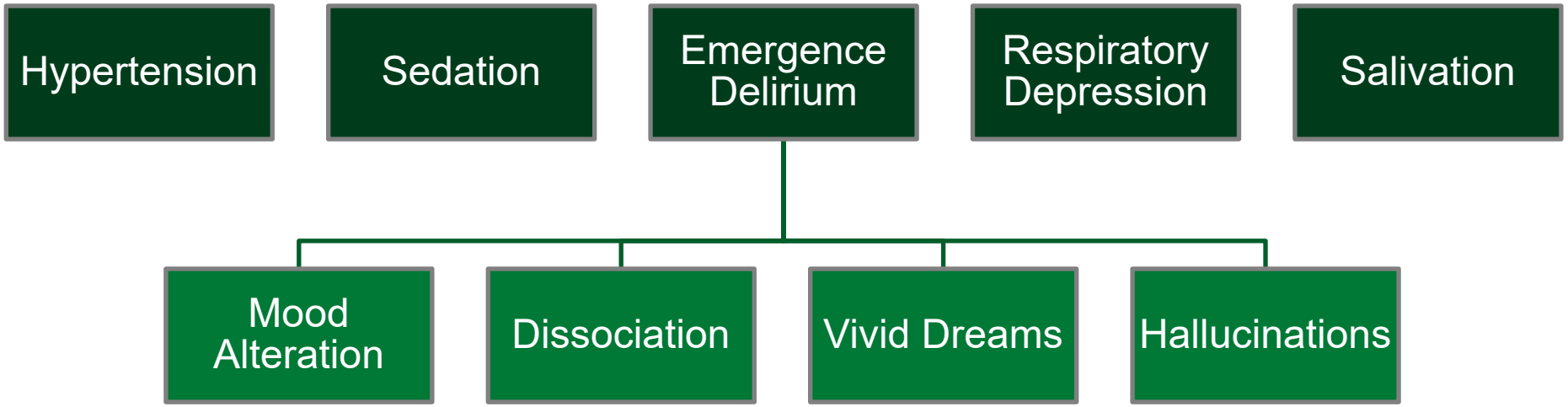
Ketamine. Lexi-Drugs.

Adverse Effects



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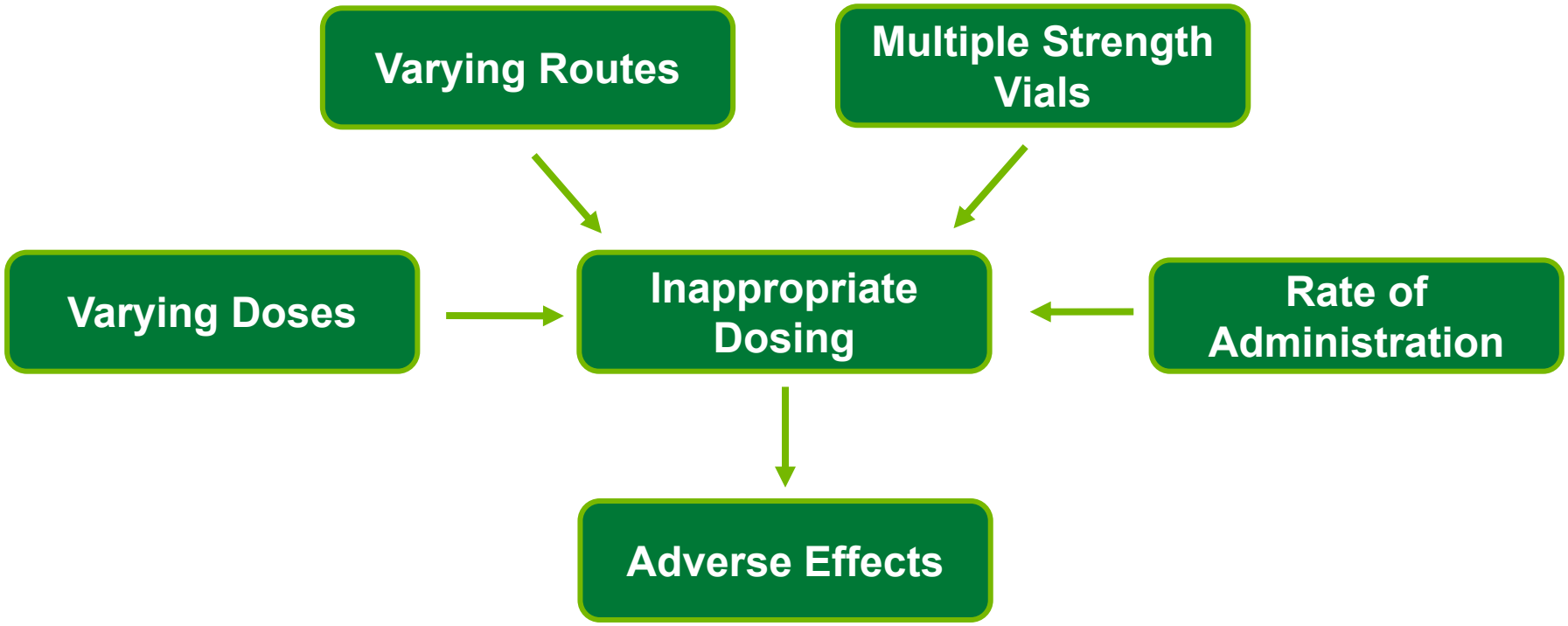
Ketamine. Lexi-Drugs.

Factors Influencing Adverse Events



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Ketamine Dosing

Indication	Dose	Subdissociative or Dissociative
Rapid Sequence Intubation (RSI)	1 – 4.5 mg/kg Intravenous (IV) 4 – 13 mg/kg Intramuscular (IM)	Dissociative
Procedural Sedation	1 – 2 mg/kg IV 4 – 5 mg/kg IM	Dissociative
Pain	0.2 – 0.8 mg/kg IV 0.5 – 1 mg/kg Intranasal (IN) 0.5 mg/kg Oral (PO)	Subdissociative
Agitated Delirium	4 – 6 mg/kg IM 1 – 2 mg/kg IV	Dissociative
Status Asthmaticus	1 – 2 mg/kg IV	Dissociative

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Ketamine. Lexi-Drugs.
Indian J Crit Care Med. 2013 May-Jun;17(3):154-61.
Academic Emergency Medicine. 2018;00:1-11.
Journal of Emergency Medicine. 2018 Nov;55(5):670–81.
International Journal of Critical Illness & Injury Science. 2016 Apr;6(2):79–84

Test Your Knowledge

- Subdissociative dosing of ketamine is utilized for which off-label indication?
  a) Pain
  b) Procedural sedation
  c) Rapid sequence intubation
  d) Agitated delirium

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Test Your Knowledge

- Subdissociative dosing of ketamine is utilized for which off-label indication?

  a) Pain

  b) Procedural sedation

  c) Rapid sequence intubation

  d) Agitated delirium

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Test Your Knowledge

- What is the most appropriate dose of ketamine for status asthmaticus?
  a) 5 mg/kg IM
  b) 1 mg/kg IV push
  c) 0.3 mg/kg IV push
  d) 2 mg/kg PO

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Test Your Knowledge

- What is the most appropriate dose of ketamine for status asthmaticus?
  a) 5 mg/kg IM
  b) 1 mg/kg IV push
  c) 0.3 mg/kg IV push
  d) 2 mg/kg PO

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Baird, et al.

- Intervention: Emergency Department (ED) adult ketamine order panel
- Indications
  - RSI
  - Procedural sedation
  - Pain
- Pre-Post Study
- Primary Outcome: Appropriate Dose
  - OR = 2.94, 95% confidence interval (1.1-7.8), p = 0.0231

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Hospital Pharmacy. 2017;52(7)483:7.

Parkview Health

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Purpose

- Following the implementation of an ED adult ketamine order set, evaluate:
  - Appropriateness of ketamine dosing
  - Patient outcomes
  - Adverse events
- Demonstrate benefit of pharmacy-driven education

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Objectives

Primary Objective

- Evaluate appropriateness of ketamine dose for indication
  - Before and after order set implementation

Secondary Objectives

- Describe adverse events
- Assess impact of pharmacy-driven education on comfort level for
  - Physicians
  - Pharmacists
  - Nurses

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Study Design and Statistical Analysis

Study Design

- Institution Review Board Approved
- Multicenter
- Retrospective
- Pre-Post Intervention
- Cohort Study

Statistical Analysis

- Primary Outcome
  - Mann-Whitney U Test
- Secondary Outcomes
  - Adverse Effects
    - Wilcoxon Signed Rank
  - Survey Data
    - Mann-Whitney U Test

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Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients ≥ 18 years old
- Presenting to the ED at any Parkview Hospital
- Receiving ≥ 1 dose of ketamine
  - Intravenous (IV) push
  - Intramuscular (IM)
  - Intranasal (IN)

Exclusion Criteria

- Pregnant
- Continuous IV infusion
- Pre-hospital ketamine administration

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ED Adult Ketamine Order Set

RSI

- 1 - 2 mg/kg IV push once

Procedural Sedation

- 0.5 – 2 mg/kg IV push once, may repeat x1 q10min
- 1 – 3 mg/kg IM once, may repeat x1 q10min

Pain Management

- 0.3 mg/kg IV push once, may repeat x1 q20min
- Admin Comments: max single dose = 30mg, dilute to 10ml with NS

Intranasal Ketamine for Pain

- 1 mg/kg intranasal (IN) once

Agitated Delirium

- 5 mg/kg IM once, may repeat x1 q10min

Status Asthmaticus

- 1 mg/kg IV push, may repeat x1 q10min

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Survey Questions

Physician	Pharmacist	Nursing
• Familiarity with ketamine dosing • Comfort level dosing ketamine • Likelihood of ordering ketamine	• Familiarity with ketamine dosing • Comfort level verifying ketamine orders	• Comfort level administering ketamine • Comfort level monitoring patients after administration of ketamine

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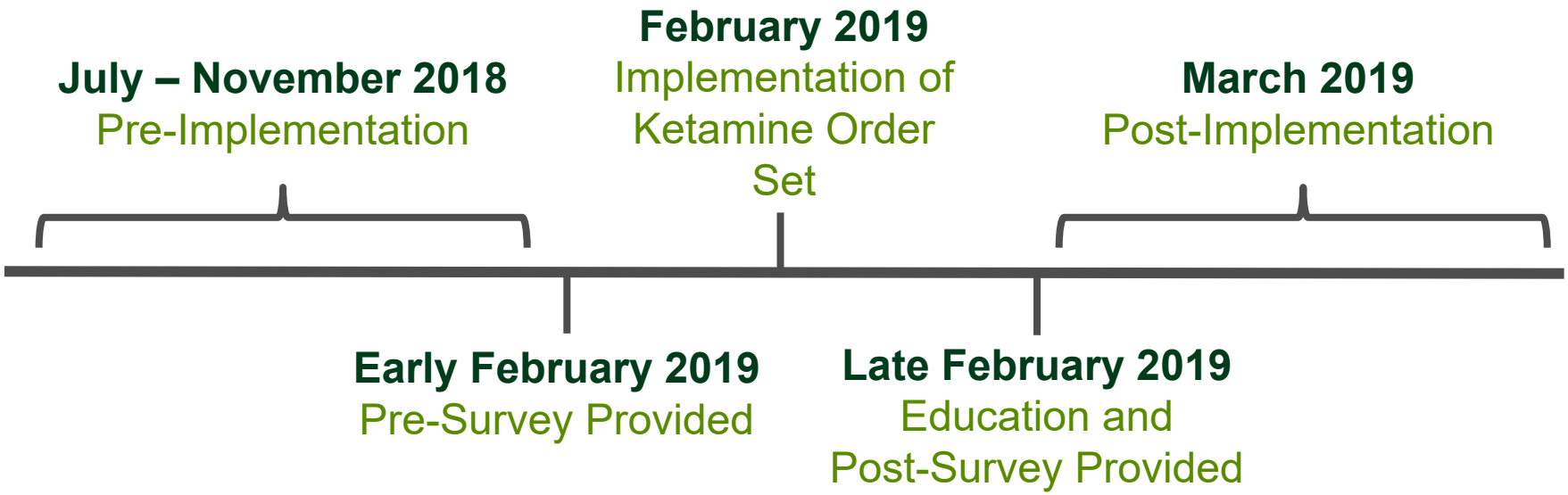
Protocol Timeline



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PATIENT RESULTS

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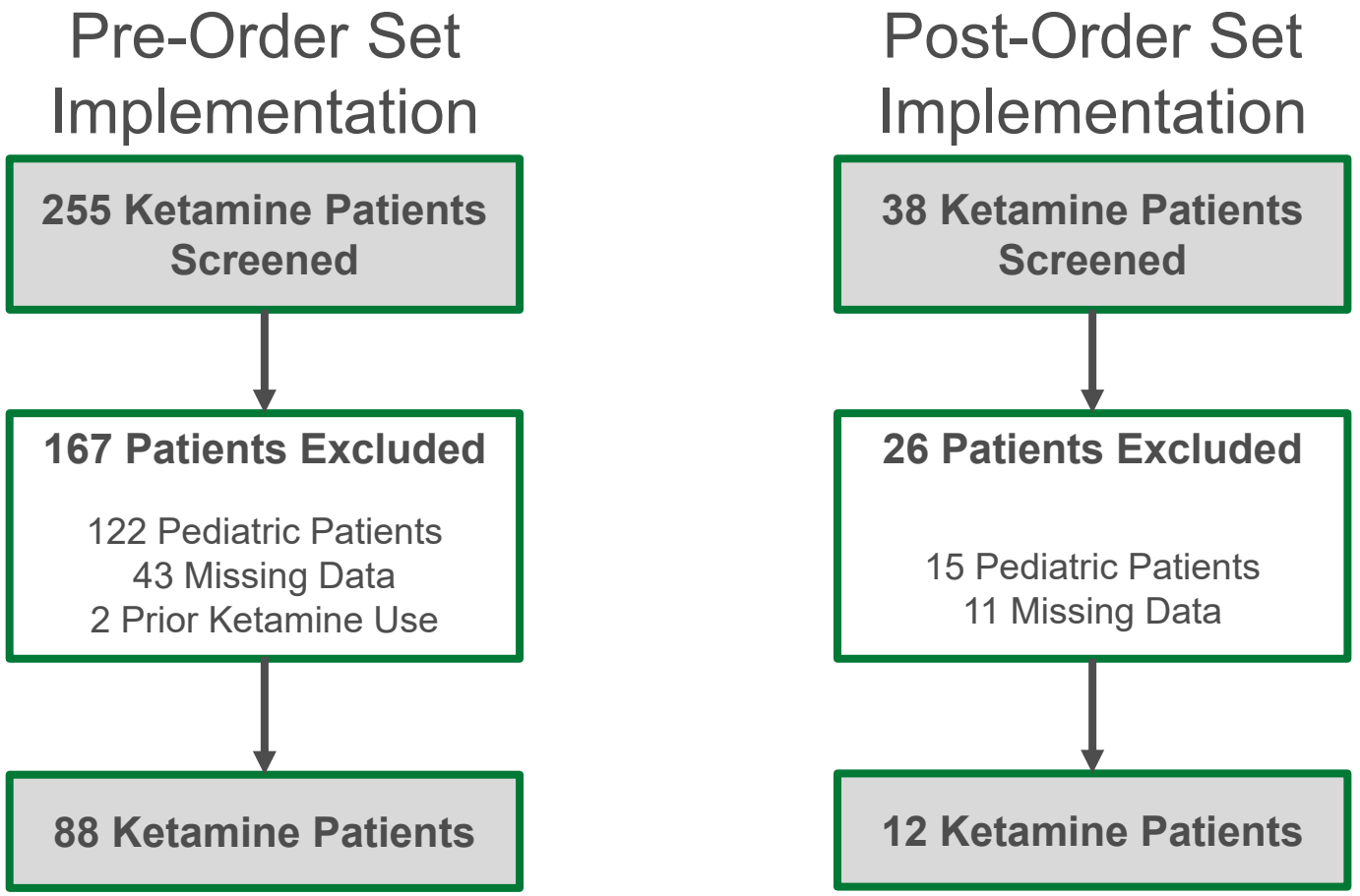
Study Population



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Baseline Characteristics

	Pre-Implementation (n = 88)	Post-Implementation (n = 12)
Gender, male [n (%)]	47 (53)	7 (58)
Age, years [median (IQR)]	51 (34 – 66)	60 (48 – 69)
Weight, kilograms [median (IQR)]	82 (65 – 100)	75 (70 – 98)
Psychiatric Comorbidity [n (%)]	5 (6)	1 (8)
Drug Abuse [n (%)]	6 (7)	4 (33)

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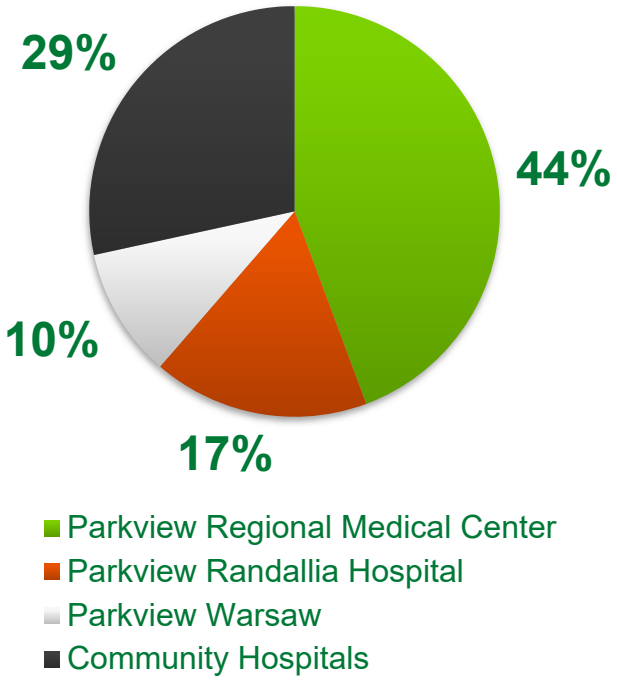
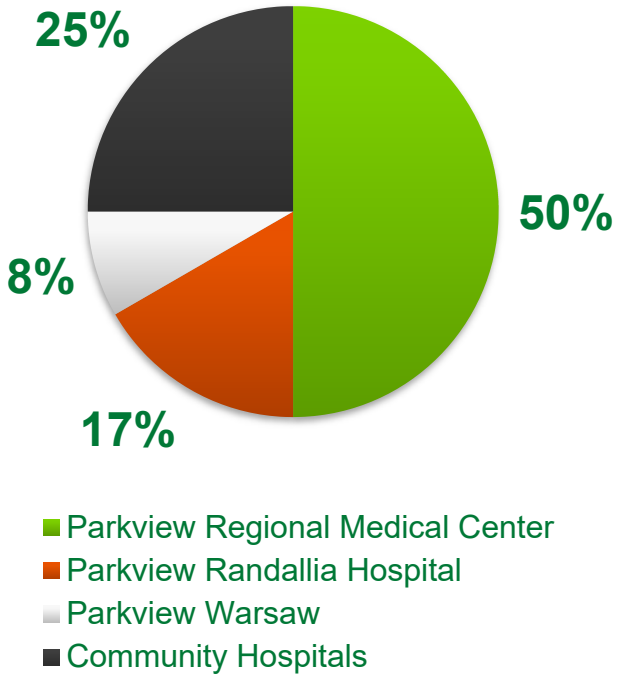
Ketamine Use by Facility

Ketamine Use Prior to Implementation (n = 88)



Ketamine Use After Implementation (n = 12)



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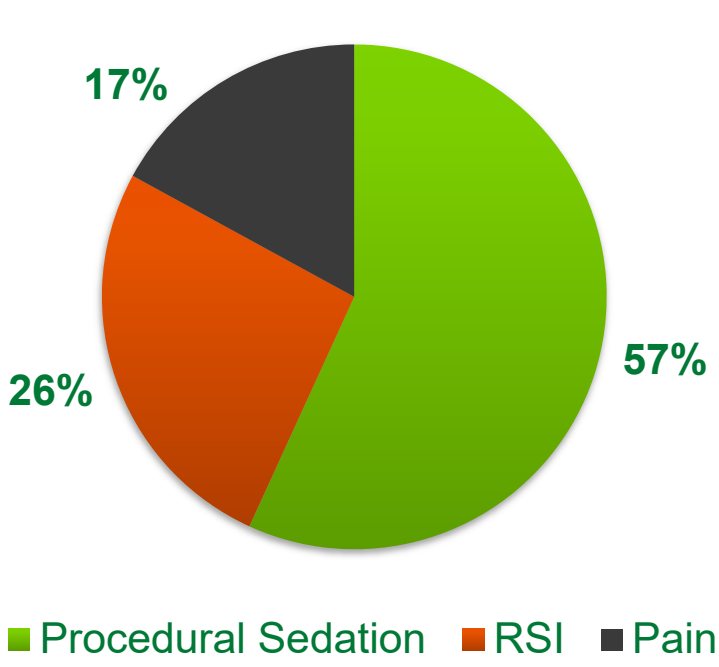
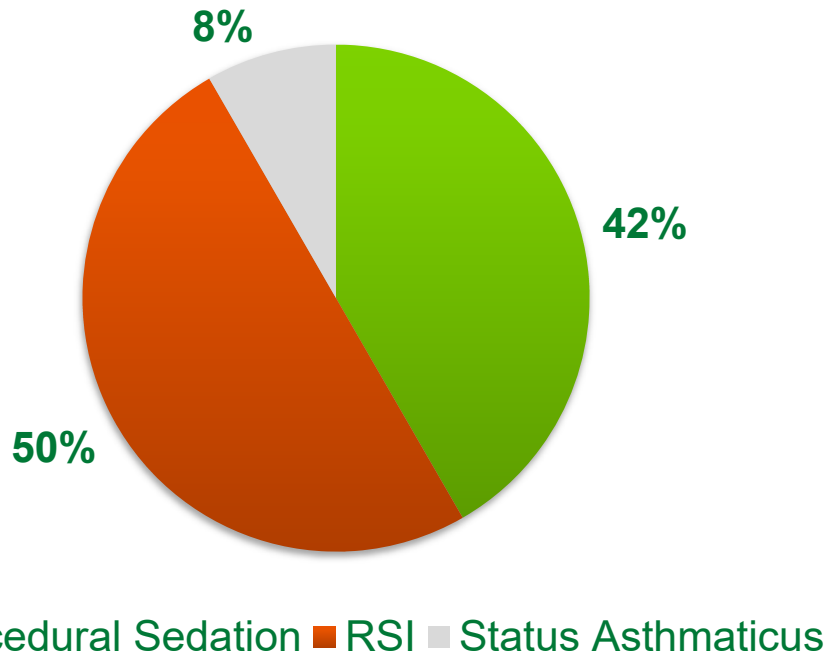
Ketamine Use by Indication

Ketamine Use Prior to Implementation (n = 88)



Ketamine Use After Implementation (n = 12)



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Results – Primary Outcome
Percent Appropriate by Indication

	Pre-Implementation		Post-Implementation		
Indication (Reference Range)	N	Appropriateness [n (%)]	N	Appropriateness [n (%)]	P-Value
Procedural Sedation (IV: 0.5 – 2 mg/kg IM: 1 – 3 mg/kg)	47	27 (57)	5	5 (100)	0.0656
RSI (IV: 1 – 2 mg/kg)	26	21 (81)	5	4 (80)	0.9687
Pain (IV: 0.3 mg/kg IN: 1 mg/kg)	15	12 (80)	1	0 (0)	0.1380
Status Asthmaticus (IV: 1 mg/kg)	0	-	1	0 (0)	-
Overall	88	60 (68)	12	9 (75)	0.5814

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Results – Secondary Outcome

	Pre-Implementation [Median (IQR)] (n = 88)	Post-Implementation [Median (IQR)] (n = 12)	P-Value
Pre-Ketamine SBP	126 (108 – 148)	132 (111 – 140)	0.9239
Post-Ketamine SBP	134 (112 – 158)	124 (112 – 140)	0.5885
Pre-Ketamine Pulse, BPM	92 (75 – 107)	96 (80 – 104)	0.7583
Post-Ketamine Pulse, BPM	90 (78 – 108)	99 (88 – 113)	0.2453

SBP: Systolic blood pressure (reported in mmHg)
BPM: Beats per minute

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Results – Secondary Outcome

	Pre-Implementation [Median (IQR)] (n = 88)	Post-Implementation [Median (IQR)] (n = 12)	P-Value
Pre-Ketamine RR	20 (16 – 24)	19 (17 – 22)	0.8234
Post-Ketamine RR	18 (15 – 23)	21 (18 – 25)	0.1024
Pre-Ketamine O2 Saturation, %	98 (96 – 100)	99 (94 – 100)	0.8345
Post-Ketamine O2 Saturation, %	99 (96 – 100)	98 (95 – 100)	0.5435

RR: respiratory rate, reported in breaths per minute
O2: oxygen

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Results – Secondary Outcome

	Pre-Implementation (n = 88)	Post-Implementation (n = 12)	P-Value
O2 Intervention (n, %)			
Nasal cannula	16 (18)	3 (25)	0.5741
Unplanned Intubation	2 (2)	1 (8)	0.2507
Bag valve mask	1 (1)	0 (0)	0.7119

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Results – Secondary Outcome

	Pre-Implementation		Post-Implementation		
	N	GCS [Median (IQR)]	N	GCS [Median (IQR)]	P-Value
Pre-Ketamine GCS Non-Intubated	59	15 (15 – 15)	5	15 (15 – 15)	0.5614
Post-Ketamine GCS Non-Intubated	59	13 (8 – 15)	5	14 (14 – 15)	0.3320
Pre-Ketamine GCS Intubated	29	15 (3 – 15)	7	11 (11 – 11)	0.5419
Post-Ketamine GCS Intubated	29	3 (3 – 8)	7	3 (3 – 4)	0.4263

GCS: Glasgow Coma Scale

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Results – Secondary Outcome

	Pre-Implementation [n (%)] (n = 88)	Post-Implementation [n (%)] (n = 12)	P-Value
Benzodiazepine Use	1 (1)	0 (0)	0.7119
Atropine Use	0 (0)	0 (0)	-
Glycopyrrolate Use	9 (10)	0 (0)	0.2479

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SURVEY RESULTS

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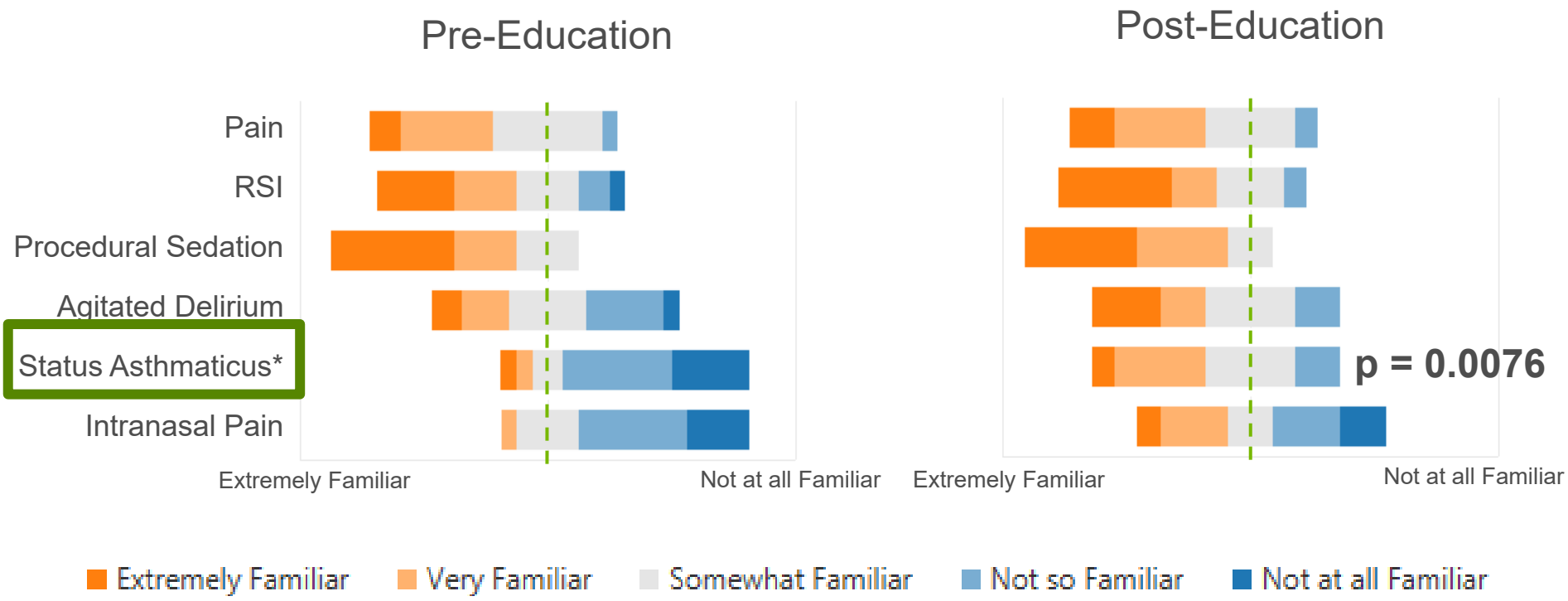
Physician Familiarity with Ketamine Dosing



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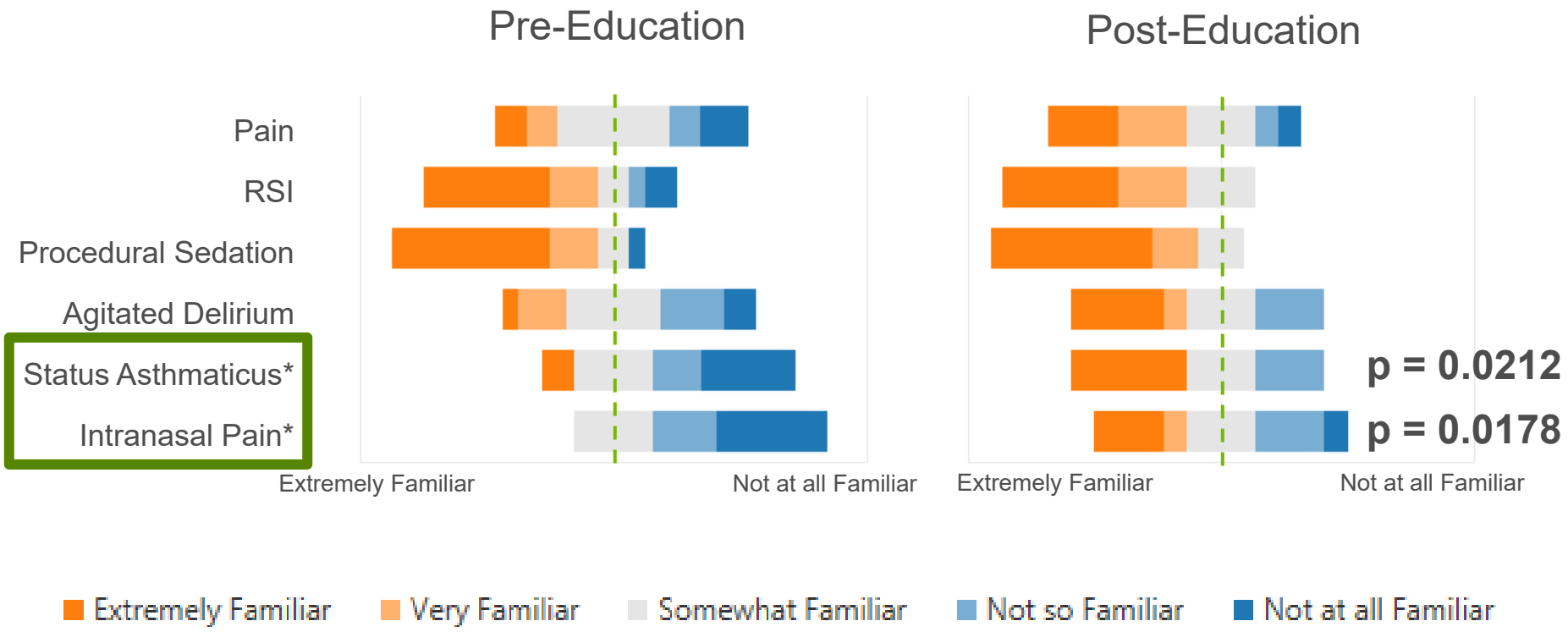
Physician Comfort with Ketamine Dosing



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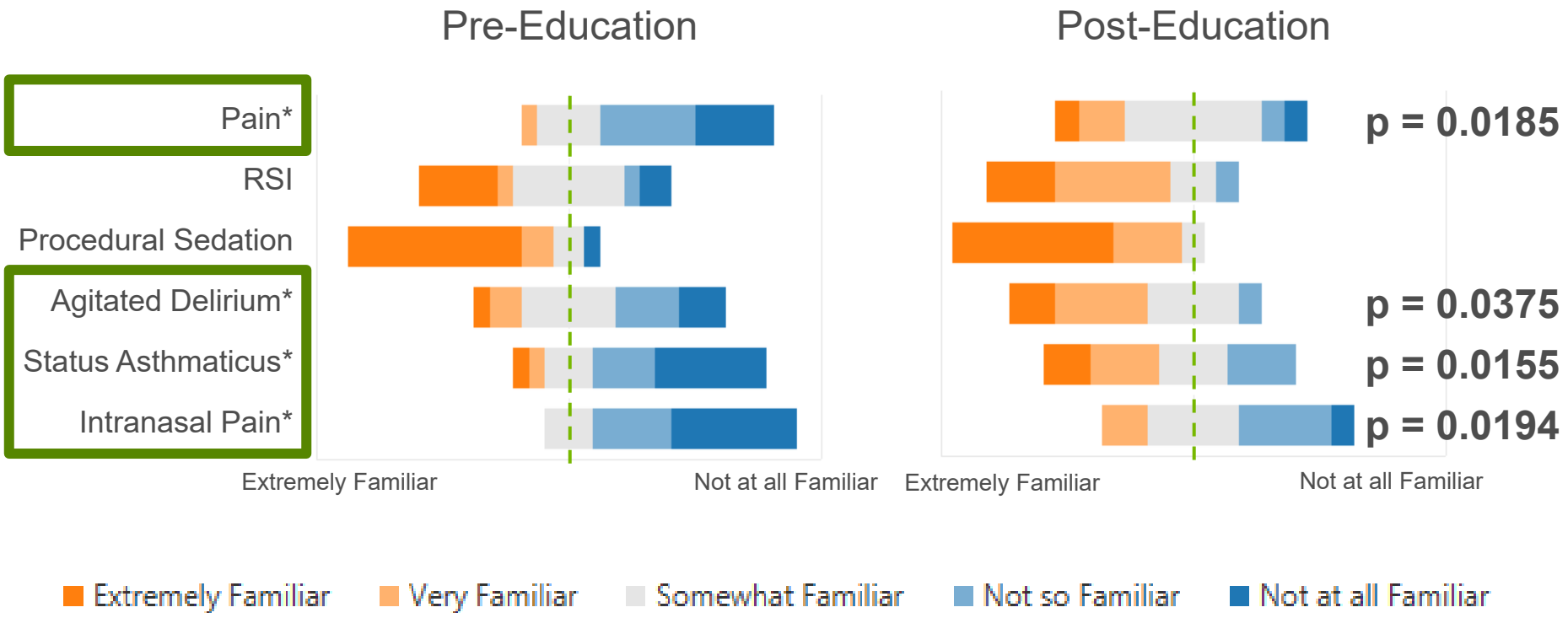
Physician Likelihood of Ordering Ketamine



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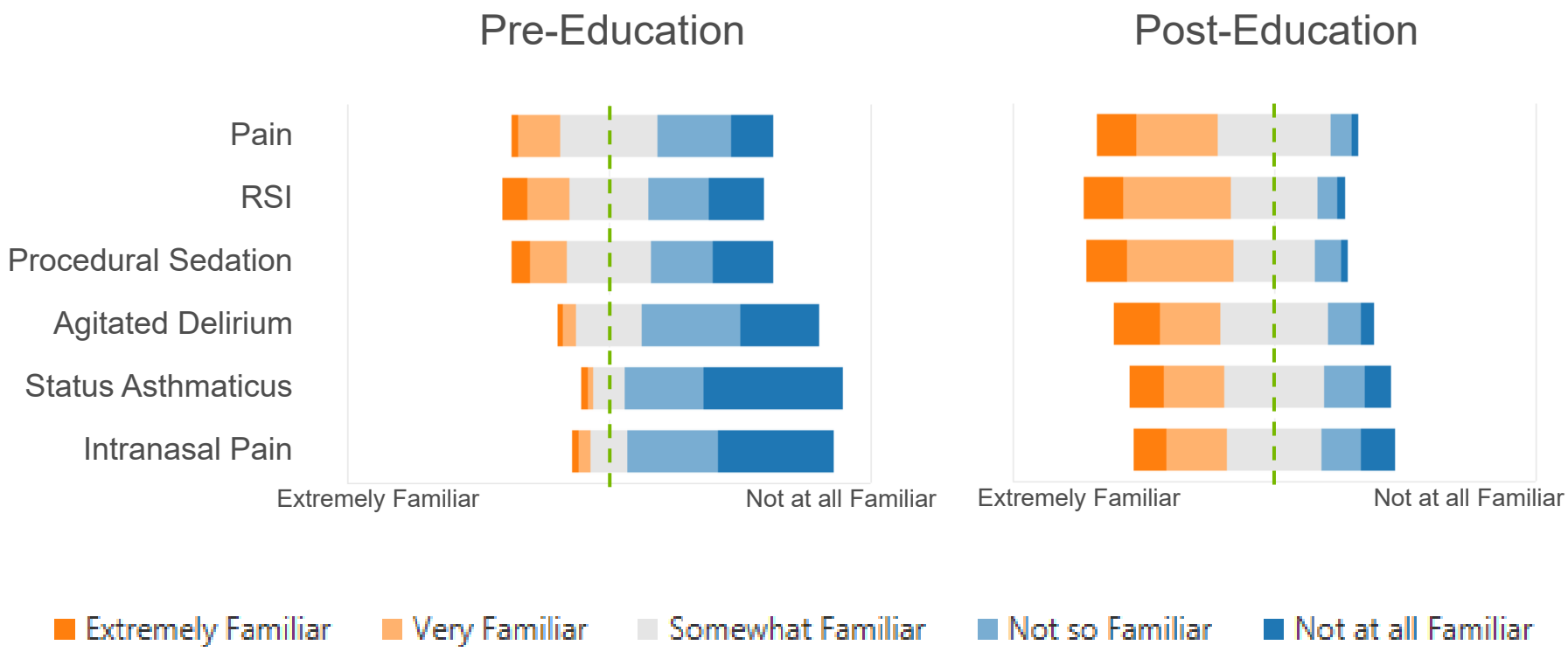
Pharmacist Familiarity with Ketamine Dosing



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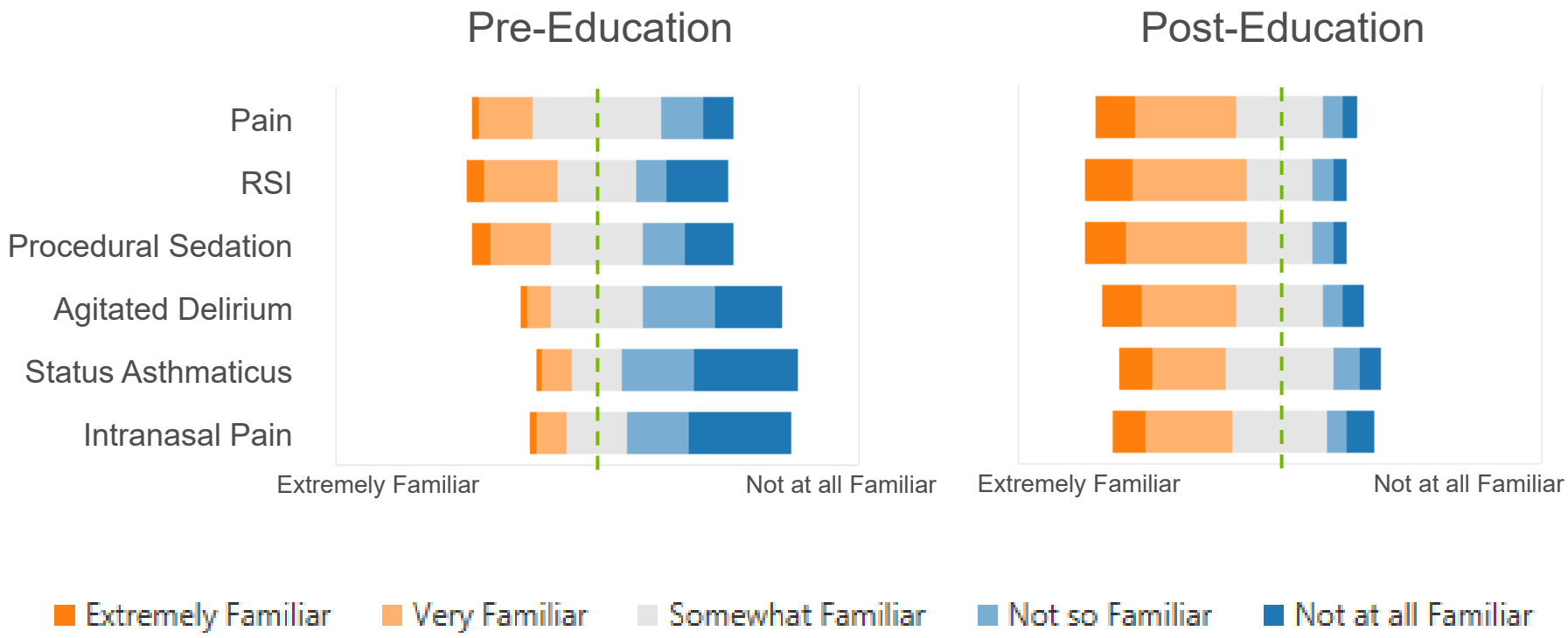
Pharmacist Comfort Level with Verifying Ketamine Orders



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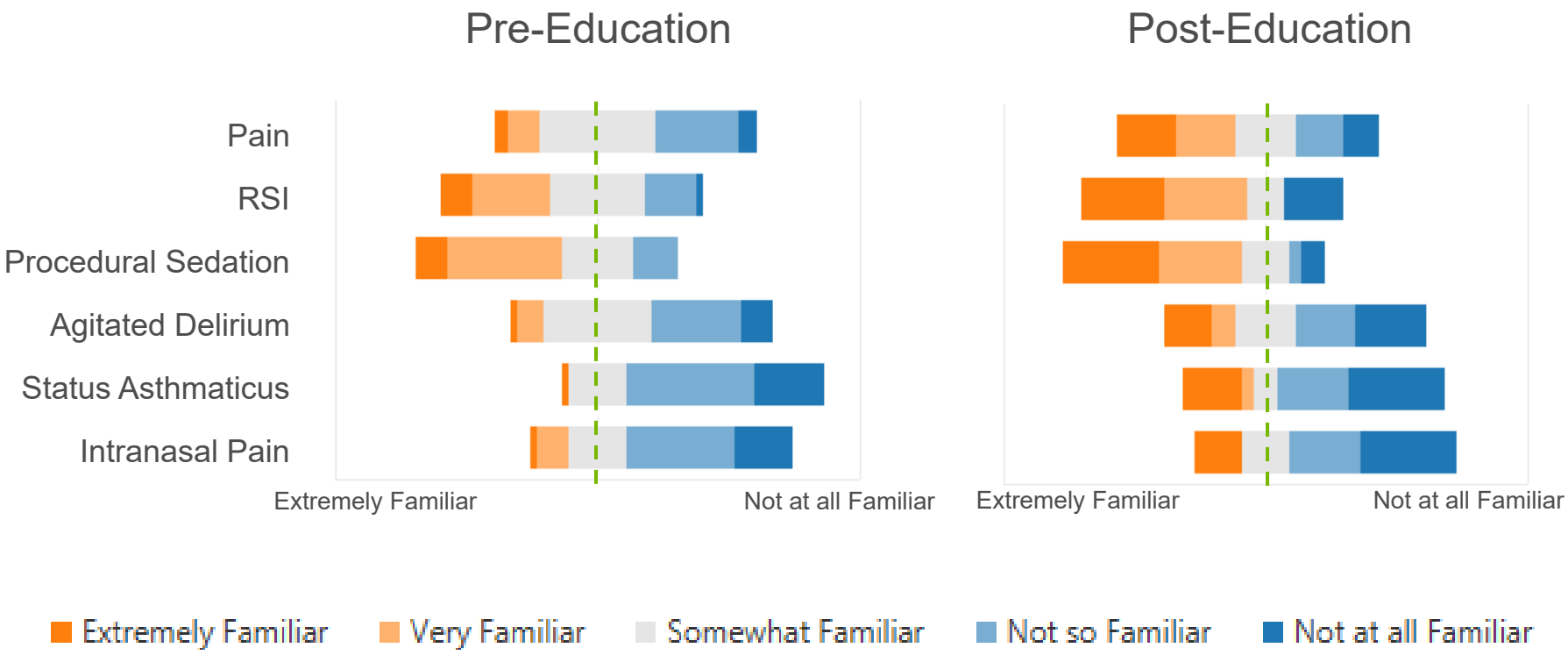
Nursing Comfort Level Administering Ketamine



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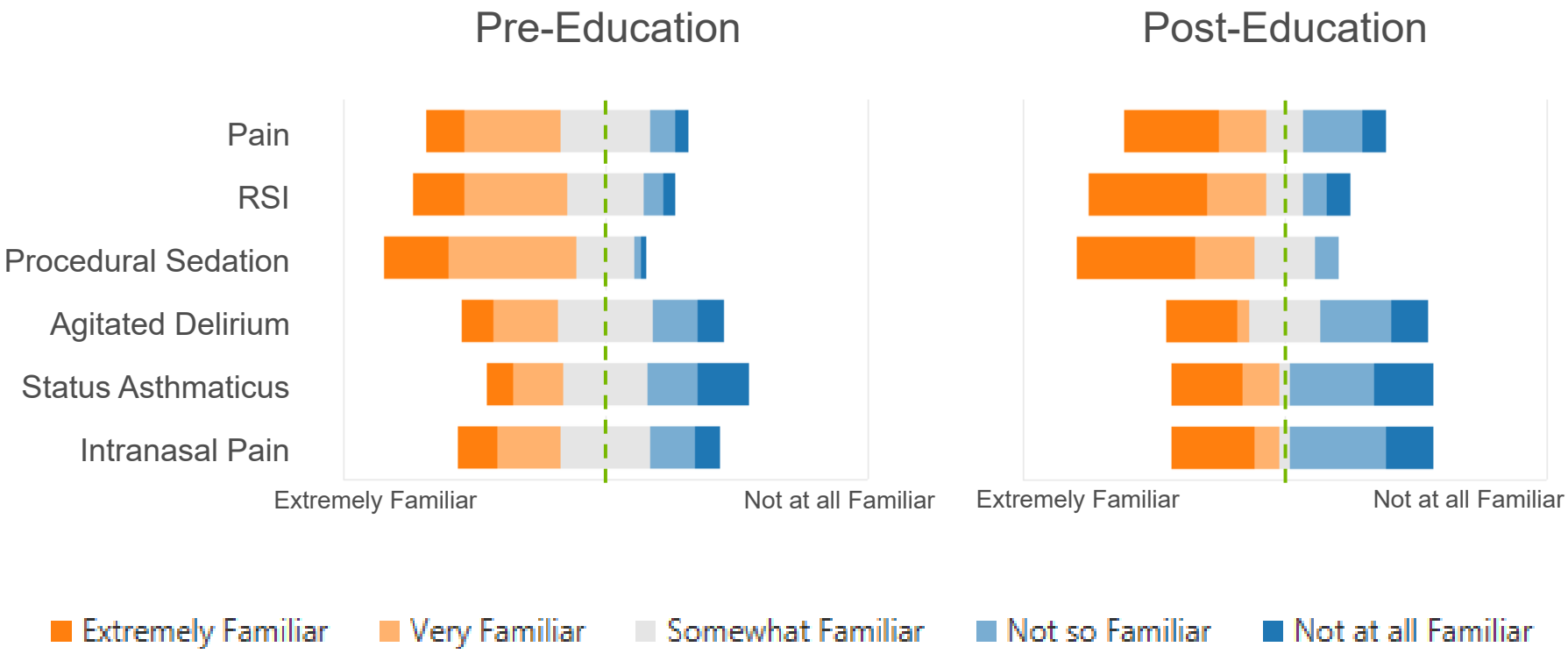
Nursing Comfort Level Monitoring Patients



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Discussion

- Most common indications
  - RSI
  - Procedural Sedation
- Multiple doses
  - Failure to respond vs. continued sedation
- Limited use of order set
  - Recent implementation
  - Acuity of situation
- Low rates of adverse effects
  - Low GCS → intubated patients
- Use in schizophrenia

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Conclusions

- Trend towards increased appropriate doses
- No clinically relevant differences in adverse effects
- Education increased familiarity, comfort level, and likelihood of ordering ketamine

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Limitations

- Retrospective nature
- Small sample size
- Underpowered
- Post-order set sample includes patients who did not have ketamine ordered from the order set
- Acuity of patients
- Timeline

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Future Direction

- Discuss incorporating into nursing quick orders
- Encourage utilization of ketamine order set
- Creation of pediatric ketamine order set

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Acknowledgements

- Sarah E. Meeks, PharmD
- Kassandra A. Foellinger, PharmD, BCPS
- Sarah Ferrell, PharmD

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