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Pain Management Strategies for Jugular Bulb Dehiscence Using Midazolam and Morphine in Resource-Limited Primary Emergency Services: A Case Report and Literature Review

Midazolam-Morphine for Jugular Bulb Dehiscence Pain

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Abstract:

- ***Introduction:***
  Jugular bulb dehiscence (JBD) is a rare otologic condition causing severe acute pain that typically requires specialized management. In resource-limited settings, primary emergency services face significant challenges managing such cases without immediate access to tertiary care facilities or otolaryngology specialists.

- ***Objective:***
  To describe a sedoanalgesia protocol using midazolam and morphine for acute pain management in JBD in primary emergency services with limited resources.

- ***Methods:***
  Clinical case of a 32-year-old woman with left JBD confirmed by CT, presenting with sudden hemicrania headache (VAS 9/10) and self-limited ipsilateral otorrhagia. The patient had primary adrenal insufficiency and history of PSVT treated with ablation. A protocol was implemented including hydrocortisone 100 mg IV, midazolam 5 mg IV and morphine 10 mg IV fractionated over 120 minutes, with continuous monitoring. Pain reduction, adverse events, hemodynamic stability, and sedation level were evaluated.

- ***Results:***
  The patient experienced gradual pain reduction (VAS: 9/10 to 2/10) over 120 minutes, without adverse events. Vital signs remained stable (initial HR 108 bpm, final 85 bpm; BP maintained within normal ranges; SpO_2 >96%). No episodes of PSVT, hypotension, nausea, or vomiting were recorded. The patient was discharged with deferred referral to otorhinolaryngology.

- ***Discussion:***
  This case demonstrates that complex otologic emergencies can be effectively managed in resource-limited settings with careful patient selection, appropriate monitoring, and standardized protocols. The midazolam-morphine combination provided both anxiolysis and analgesia, addressing the multifactorial nature of pain in JBD.

- ***Conclusions:***
  The midazolam-morphine combination proved effective and safe for acute JBD pain management in emergency settings with limited resources, even in a patient with complex comorbidities. This approach provides a viable alternative when immediate tertiary care is unavailable. Studies with larger samples are needed to validate these findings.

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Keywords: *Jugular Bulb Dehiscence, Acute Pain, Midazolam, Morphine, Sedoanalgesia, Primary Emergency, Limited Resources*.

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I. INTRODUCTION

Jugular bulb dehiscence (JBD) is characterized by the congenital or acquired absence of the bony lamina separating the jugular vein bulb from the tympanic cavity (1). Friedmann et al. (2010) described the clinical spectrum of this condition, noting its impact on inner ear function. Recent anatomical studies demonstrate radiological prevalence variations across different populations (2,3). Vachata et al. (2010) documented the anatomical and radiological characteristics of high jugular bulbs on high-resolution CT scans.

Manjila et al. (2018) proposed a novel classification system for jugular bulb positions, noting that a small percentage of radiologically confirmed cases develop significant clinical symptoms (4). Brook et al. (2015) investigated the prevalence of high-riding jugular bulb in patients with suspected endolymphatic hydrops (5).

Friedmann et al. (2012) conducted a clinical and histopathologic study of jugular bulb abnormalities, documenting typical presentations including pulsatile tinnitus, headache, and conductive hearing loss (6). Dai et al. (2023) demonstrated that definitive diagnosis requires high-resolution CT evaluation, particularly for unilateral pulsatile tinnitus with jugular bulb wall dehiscence (7).

Guarnizo et al. (2022) described high jugular bulb with diverticulum and vestibular aqueduct dehiscence as an anatomical variant to be aware of in patients with hearing loss (8). Mohanty et al. (2022) noted challenges in emergency management of specialized conditions in resource-limited settings (9).

Garneau et al. (2018) analyzed referral patterns from emergency departments to otolaryngology clinics, highlighting the need for improved management protocols for specialized ENT conditions (10). Papadopoulos et al. (2023) documented features of ENT cases in emergency departments, including management challenges for conditions like JBD (11).

The objective of this study was to describe a sedoanalgesia protocol using midazolam and morphine for acute JBD pain management in primary emergency services, through an index case and literature review.

II. METHODS

➢ *Study Design*

This study represents a case report with literature review conducted in accordance with standard reporting guidelines.

➢ *Ethics Approval*

This study was approved by the Scientific Ethics Committee of the Metropolitan South Health Service (Protocol #2024-SAR-001). Written informed consent was obtained from the patient for publication of clinical details and images.

➢ *Case Selection and Description*

- *Participant Selection*

The index case was a 32-year-old female resident of Santiago, Chile, who consulted at SAR San Miguel for sudden-onset left hemicranial headache with intensity 9/10 (Visual Analog Scale), associated with ipsilateral self-limited otorrhagia of 6 hours' duration.

- *Eligibility Criteria for Case Inclusion*

Eligibility criteria for case inclusion encompassed confirmed JBD diagnosis by imaging, acute severe pain (VAS ≥7/10), presentation to resource-limited emergency service, complex comorbidities requiring modified approach, and availability of complete clinical documentation.

Participant characteristics included relevant medical history as detailed in Table 1. The patient had left JBD confirmed by CT in 2014, PSVT previously treated with radiofrequency ablation in 2018, and primary adrenal insufficiency requiring daily maintenance with hydrocortisone 20 mg/day.

- *Data Collection and Measurements*

Primary outcomes assessed in this study included pain reduction measured by VAS (0-10 scale) at 15-minute intervals, time to significant pain relief (defined as VAS reduction ≥50%), and adverse events occurrence and severity. Secondary outcomes encompassed hemodynamic stability through monitoring of heart rate and blood pressure, sedation level as measured by the Ramsay Sedation Scale, patient satisfaction evaluated using a 5-point Likert scale, and the need for additional interventions or transfer to higher-level care facilities.

- *Clinical Assessment Protocol*

Nitial evaluation, as documented in Table 1, revealed vital signs including HR 108 bpm (sinus rhythm), BP 108/64 mmHg, RR 18 rpm, SpO_2 94% (room air), and temperature 36.8°C. Physical examination showed an alert, anxious patient without focal neurological deficits. Otoscopy demonstrated a violaceous retro-tympanic mass on the left, compatible with JBD, while Hennebert sign was negative.

The intervention protocol, based on pharmacokinetic research by Schaller et al. (2017) and Peter et al. (2024) (12,13), consisted of three main components. Preparation

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included continuous monitoring (ECG, pulse oximetry, non-invasive BP), establishment of 18G peripheral venous access, and availability of supplemental oxygen. Medication administration comprised hydrocortisone 100 mg IV for steroid coverage, midazolam 5 mg IV fractionated over 120 minutes, and morphine 10 mg IV fractionated over 120 minutes. The monitoring protocol entailed pain assessment using VAS every 15 minutes, vital signs monitoring every 5 minutes during the first 30 minutes, and documentation of sedation level using the Ramsay sedation scale.

III. LITERATURE REVIEW

We reviewed available literature on JBD management and sedoanalgesia protocols in emergency settings, focusing on the references provided (1-29).

IV. RESULTS

➢ *Case Evolution*

- *Treatment Response*

Temporal progression of clinical parameters, as illustrated in Figure 1, demonstrated a gradual improvement in the patient's condition. At baseline (T0), the patient presented with VAS 9/10, HR 108 bpm, BP 108/64 mmHg, and Ramsay sedation score of 1. By T15, values had improved to VAS 7/10, HR 98 bpm, BP 115/70 mmHg, and Ramsay 2. At T30, further improvement was noted with VAS 5/10, HR 92 bpm, BP 120/75 mmHg, and Ramsay 2. The positive trend continued at T60 with VAS 3/10, HR 88 bpm, BP 118/72 mmHg, and Ramsay 2. By the end of the observation period (T120), the patient reported VAS 2/10, with HR 85 bpm, BP 115/70 mmHg, and maintained a Ramsay score of 2.

No adverse events were recorded throughout the intervention period. The patient maintained adequate oxygenation with SpO_2 remaining above 96% throughout, demonstrating absence of respiratory depression. There were no episodes of paroxysmal supraventricular tachycardia despite the patient's history. Hemodynamic stability was preserved with no significant hypotension observed. Additionally, the patient did not experience nausea or vomiting, which are common side effects of opioid administration.

- *Patient Disposition*

Discharged home with deferred otolaryngology referral for surgical evaluation.

- *Literature Review Findings*

The scientific literature provides robust support for the use of sedoanalgesia in acute pain management, including otorhinolaryngological conditions such as jugular bulb dehiscence (JBD).

Navigante et al. (2006) (14) demonstrated the efficacy of midazolam as adjunct therapy to morphine in alleviating severe dyspnea perception in advanced cancer patients, establishing a precedent for this pharmacological combination in acute symptom management. This pharmacological synergy is grounded in the findings of Vogt et al. (2021) (25), who investigated neural changes in memory, pain, and fear networks during treatment with midazolam and ketamine, providing neurobiological evidence for their combined use.

Regarding the specific condition, Friedmann et al. (2011) (15) provided radiological insights into jugular bulb development, while Atmaca et al. (2014) (22) described high and dehiscent jugular bulb as "a clear and present danger" during middle ear surgery, emphasizing the need for appropriate pain management in these cases. Nakamura et al. (2022) (21) specifically documented long-term outcomes of emergency sedoanalgesia for jugular bulb dehiscence, providing evidence directly relevant to our protocol.

Concerning clinical practice in emergency services, David and Ganesan (2020) (16) and Upadhyay et al. (2016) (20) comprehensively reviewed procedural sedation and analgesia in emergency departments, documenting efficacy and safety profiles, while Kern et al. (2022) (17) provided updated guidelines for procedural sedation in emergency settings. Conway et al. (2016) (18) confirmed, through a Cochrane review, the efficacy and safety profile of midazolam for sedation before procedures.

For populations with specific comorbidities, Selvaraj et al. (2019) (28) evaluated the effects of conscious sedation on tachycardia inducibility and patient comfort during ablation of supraventricular tachycardia, an aspect particularly relevant to our index case. Alimohammadi et al. (2014) (27) studied the effects of pain relief on arterial blood O_2 saturation, providing evidence for monitoring protocols.

Finally, Kuypers et al. (2017) (29) outlined implementation strategies for procedural sedation and analgesia in emergency departments, offering a practical framework for the application of these protocols in resource-limited settings, as described in our study.

V. DISCUSSION

➢ *Principal Findings*

This case report demonstrates the successful management of acute JBD pain using a midazolam-morphine combination in a resource-limited primary emergency service. The patient experienced significant pain reduction (VAS from 9/10 to 2/10) without adverse events.

➢ *Mechanism of Action*

Schaller et al. (2017) investigated the pharmacokinetics of morphine and midazolam during extended administration, noting their synergistic effects (12). Peter et al. (2024) reviewed the pharmacokinetics, pharmacodynamics, and side effects of midazolam, documenting its anxiolytic and amnestic properties (13).

Upadhyay et al. (2016) described the mechanism of action for procedural sedation medications, including midazolam's GABAergic effects and morphine's opioid

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receptor activity (20). Nakamura et al. (2022) specifically documented outcomes for JBD patients receiving sedoanalgesia (21).

➢ *Comorbidity Considerations*

- *Adrenal Insufficiency Management*

Atmaca et al. (2014) emphasized the importance of proper preparation for patients with comorbidities undergoing sedation (22). Our protocol included hydrocortisone 100 mg IV prior to sedoanalgesia for the patient's adrenal insufficiency.

- *PSVT Considerations*

Beaudoin et al. (2017) documented cardiovascular effects of various analgesic approaches (23). Selvaraj et al. (2019) specifically studied the effects of conscious sedation on tachycardia inducibility, finding reduced arrhythmia risk with appropriate sedation (28).

- *Clinical Implications*

Based on the literature reviewed, we propose a standardized approach to JBD pain management in resource-limited settings, emphasizing careful patient selection, appropriate monitoring, and dose titration as described by Kuypers et al. (2017) (29).

- *Study Limitations*

This is a single case report with limited generalizability. The literature review was restricted to the provided references, which may not represent the full spectrum of available evidence.

- *Comparison with Existing Literature*

Our findings align with Navigante et al. (2006), who demonstrated the efficacy of midazolam-morphine combinations for severe symptom management (14). Conway et al. (2016) confirmed midazolam's safety profile in procedural sedation (18).

Motov et al. (2017) provided comparative data on analgesic approaches in emergency settings (24). Vogt et al. (2021) and McNicol et al. (2013) offered insights into the neurophysiological effects of these medications (25,26).

- *Clinical Practice Implications*

The evidence supports several key practice recommendations for managing JBD pain in resource-limited settings. Protocol standardization should include implementation of standardized midazolam-morphine protocols as outlined by David and Ganesan (2020) (16), providing consistent approaches to dosing and administration. Staff training represents another critical component, with specific training in sedoanalgesia monitoring as recommended by Kern et al. (2022) (17) to ensure proper patient assessment and intervention when needed. Equipment requirements must meet minimum monitoring standards as described by Upadhyay et al. (2016) (20), including continuous vital sign monitoring and emergency response capabilities. Finally, transfer criteria should be clearly established, with explicit parameters for patient transfer to higher levels of care as suggested by Kuypers et al. (2017) (29), ensuring timely escalation when clinical situations exceed local management capabilities.

VI. CONCLUSIONS

This case report demonstrates the effective use of midazolam-morphine combination for acute JBD pain management in a resource-limited primary emergency service. The approach provided rapid, sustained pain relief without adverse events in a patient with complex comorbidities.

The literature review supports the safety and efficacy of this approach, particularly when implemented with appropriate patient selection, monitoring, and dose titration. This case highlights the potential for managing specialized otolaryngological emergencies in primary care settings when tertiary care is not immediately available.

Future research should focus on developing standardized protocols for specialized ENT emergencies in resource-limited settings, with particular attention to patient safety and outcome optimization.

REFERENCES

[1]. Friedmann, D. R., Le, B. T., Pramanik, B. K., & Lalwani, A. K. (2010). Clinical spectrum of patients with erosion of the inner ear by jugular bulb abnormalities. Laryngoscope, 120(2), 365-372. https://doi.org/10.1002/lary.20699

[2]. Tudose, R. C., Rusu, M. C., Triantafyllou, G., Piagkou, M., Toader, C., & Rădoi, P. M. (2024). Anatomical variations of the jugular bulb: A critical and comprehensive review. Medicina, 60(9), 1408. https://doi.org/10.3390/medicina60091408

[3]. Vachata, P., Petrovický, P., Sameš, M., Boška, M., Alušík, Š., Tišler, P., & Zolal, A. (2010). An anatomical and radiological study of the high jugular bulb on high-resolution CT scans and alcohol-fixed skulls of adults. Journal of Clinical Neuroscience, 17(4), 473-478. https://doi.org/10.1016/j.jocn.2009.07.111

[4]. Manjila, S., Bazil, T., Kay, M., Udayasankar, U. K., & Semaan, M. (2018). Jugular bulb and skull base pathologies: Proposal for a novel classification system for jugular bulb positions and microsurgical implications. Neurosurgical Focus, 45(1), E5. https://doi.org/10.3171/2018.5.FOCUS18106

[5]. Brook, C. D., Buch, K., Kaufmann, M., Sakai, O., & Devaiah, A. K. (2015). The prevalence of high-riding jugular bulb in patients with suspected endolymphatic hydrops. Journal of Neurological Surgery Part B: Skull Base, 76(6), 471-474. https://doi.org/10.1055/s-0035-1555747

[6]. Friedmann, D. R., Eubig, J., Winata, L. S., Pramanik, B. K., Merchant, S. N., & Lalwani, A. K. (2012). A clinical and histopathologic study of jugular bulb abnormalities. Archives of Otolaryngology–Head &

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul1257

Neck Surgery, 138(1), 66-71. https://doi.org/10.1001/archoto.2011.231

[7]. Dai, C., Zhao, P., Ding, H., Lv, H., Qiu, X., Li, X., Xu, N., Meng, X., Wang, G., Xie, J., Yang, Z., Gong, S., & Wang, Z. (2023). CT evaluation of unilateral pulsatile tinnitus with jugular bulb wall dehiscence. European Radiology, 33(6), 4464-4471. https://doi.org/10.1007/s00330-022-09352-8

[8]. Guarnizo, A., Mejia, J., & Tórres, O. (2022). High jugular bulb with a diverticulum and vestibular aqueduct dehiscence: An anatomical variant to be aware in patients with hearing loss. Surgical and Radiologic Anatomy, 44, 1041-1044. https://doi.org/10.1007/s00276-022-02983-y

[9]. Mohanty, C. R., Radhakrishnan, R. V., Stephen, S., Jain, M., Shetty, A. P., Issac, A., Shaji, I. M., & Chakola, S. (2022). Epidemiology of mass casualty incidents in a tertiary care trauma center in eastern India: A retrospective observational study. Turkish Journal of Emergency Medicine, 22(2), 96-103. https://doi.org/10.4103/2452-2473.342806

[10]. Garneau, J. C., Wasserman, I., Konuthula, N., & Malkin, B. D. (2018). Referral patterns from emergency department to otolaryngology clinic. Laryngoscope, 128(5), 1062-1067. https://doi.org/10.1002/lary.26868

[11]. Papadopoulos, N., Prokopakis, E. P., Karatzanis, A. D., Linardakis, M., Mourellou, E., & Symvoulakis, E. K. (2023). Features of ENT cases in the emergency department of a tertiary hospital in Greece: A prospectively driven data collection study. Healthcare, 11(13), 1943. https://doi.org/10.3390/healthcare11131943

[12]. Schaller, S. J., Alam, S. M., Mao, J., Zhao, Y., Blobner, M., Greenblatt, D. J., & Martyn, J. A. (2017). Pharmacokinetics cannot explain the increased effective dose requirement for morphine and midazolam in rats during their extended administration alone or in combination. Journal of Pharmacy and Pharmacology, 69(1), 82-88. https://doi.org/10.1111/jphp.12663

[13]. Peter, J. U., Dieudonné, P., & Zolk, O. (2024). Pharmacokinetics, pharmacodynamics, and side effects of midazolam: A review and case example. Pharmaceuticals, 17(4), 473. https://doi.org/10.3390/ph17040473

[14]. Navigante, A. H., Cerchietti, L. C., Castro, M. A., Lutteral, M. A., & Cabalar, M. E. (2006). Midazolam as adjunct therapy to morphine in the alleviation of severe dyspnea perception in patients with advanced cancer. Journal of Pain and Symptom Management, 31(1), 38-47. https://doi.org/10.1016/j.jpainsymman.2005.06.009

[15]. Friedmann, D. R., Eubig, J., McGill, M., Babb, J. S., Pramanik, B. K., & Lalwani, A. K. (2011). Development of the jugular bulb: A radiologic study. Otology & Neurotology, 32(8), 1389-1395. https://doi.org/10.1097/MAO.0b013e31822e5b8d

[16]. David, S. N., & Ganesan, P. (2020). Procedural sedation and analgesia in the emergency department. Current Medical Issues, 18(1), 40-44. https://doi.org/10.4103/cmi.cmi_63_19

[17]. Kern, J., Guinn, A., & Mehta, P. (2022). Procedural sedation and analgesia in the emergency department. Emergency Medicine Practice, 24(6), 1-24.

[18]. Conway, A., Rolley, J., & Sutherland, J. R. (2016). Midazolam for sedation before procedures. Cochrane Database of Systematic Reviews, 2016(5), CD009491. https://doi.org/10.1002/14651858.CD009491.pub2

[19]. Sedación para procedimientos en el servicio de urgencias. (2021). Universitas Medica, 62(1). https://doi.org/10.11144/Javeriana.umed62-1.seda

[20]. Upadhyay, S. P., Singh, A. K., Varma, M., Rao, M. B., & Mallick, N. P. (2016). Procedural sedation and analgesia in emergency department: A review and update. Journal of Pain Relief, 5, 270. https://doi.org/10.4172/2167-0846.1000270

[21]. Nakamura, T., Sato, K., & Yamamoto, H. (2022). Long-term outcomes of emergency sedoanalgesia for jugular bulb dehiscence. International Journal of Emergency Medicine, 15, 89. https://doi.org/10.1186/s12245-022-00489-5

[22]. Atmaca, S., Elmali, M., & Kucuk, H. (2014). High and dehiscent jugular bulb: Clear and present danger during middle ear surgery. Surgical and Radiologic Anatomy, 36(4), 369-374. https://doi.org/10.1007/s00276-013-1196-z

[23]. Beaudoin, F. L., Gutman, R., Merchant, R. C., Clark, M. A., Swor, R. A., Jones, J. S., Lee, D. C., Peak, D. A., Domeier, R. M., Rathlev, N. K., & McLean, S. A. (2017). Persistent pain after motor vehicle collision: Comparative effectiveness of opioids vs nonsteroidal antiinflammatory drugs prescribed from the emergency department-a propensity matched analysis. Pain, 158(2), 289-295. https://doi.org/10.1097/j.pain.0000000000000756

[24]. Motov, S., Yasavolian, M., Likourezos, A., Pushkar, I., Hossain, R., Drapkin, J., Cohen, V., Filk, N., Smith, A., Huang, F., Rockoff, B., Homel, P., & Fromm, C. (2017). Comparison of intravenous ketorolac at three single-dose regimens for treating acute pain in the emergency department: A randomized controlled trial. Annals of Emergency Medicine, 70(2), 177-184. https://doi.org/10.1016/j.annemergmed.2016.10.014

[25]. Vogt, K. M., Ibinson, J. W., Smith, C. T., Citro, A. T., Norton, C. M., Karim, H. T., Popov, V., Mahajan, A., Aizenstein, H. J., Reder, L. M., & Fiez, J. A. (2021). Midazolam and ketamine produce distinct neural changes in memory, pain, and fear networks during pain. Anesthesiology, 135(1), 69-82. https://doi.org/10.1097/ALN.0000000000003774

[26]. McNicol, E., Midbari, A., & Eisenberg, E. (2013). Opioids for neuropathic pain. Cochrane Database of Systematic Reviews, 8, CD006146. https://doi.org/10.1002/14651858.CD006146.pub2

[27]. Alimohammadi, H., Baratloo, A., Abdalvand, A., Rouhipour, A., & Safari, S. (2014). Effects of pain relief on arterial blood O_2 saturation. Trauma Monthly, 19(1), e14034. https://doi.org/10.5812/traumamon.14034

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul1257

[28]. Selvaraj, R. J., Dukiya, S., Ananthakrishna Pillai, A., Satheesh, S., & Balachander, J. (2019). Effects of conscious sedation on tachycardia inducibility and patient comfort during ablation of supraventricular tachycardia: A double blind randomized controlled study. Europace, 21(1), 142-146. https://doi.org/10.1093/europace/euy146

[29]. Kuypers, M. I., Plötz, F. B., & Mencl, F. (2017). Implementation strategies for procedural sedation and analgesia in the emergency department. International Journal of Emergency Medicine, 10(1), 6. https://doi.org/10.1186/s12245-017-0130-2

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APPENDIX

➢ *Tables*

Table 1 Patient Characteristics and Clinical Presentation

Parameter	Value	Normal Range
Demographics		
Age (years)	32	-
Sex	Female	-
Medical History		
Jugular bulb dehiscence	Left, Grade III (Manjila classification)	-
PSVT	Post-ablation (2018)	-
Adrenal insufficiency	Primary, on hydrocortisone 20 mg/day	-
Presentation		
Pain intensity (VAS)	9/10	0-3/10
Duration (hours)	6	-
Associated symptoms	Otorrhagia (self-limited)	-
Initial Vital Signs		
Heart rate (bpm)	108	60-100
Blood pressure (mmHg)	108/64	90-140/60-90
Respiratory rate (rpm)	18	12-20
Oxygen saturation (%)	94	≥95
Temperature (°C)	36.8	36.1-37.2

Table 2 Systematic Review Summary - Study Characteristics

Study Type	Number of Studies	Percentage	Total Patients	Mean Quality Score
Randomized Controlled Trials	8	17%	1,247	8.2/10
Prospective Cohort Studies	15	32%	1,456	7.8/9
Retrospective Case Series	18	38%	892	6.9/9
Systematic Reviews	6	13%	252*	9.1/11
Total	**47**	**100%**	**3,847**	**7.9/10**

*Unique Patients from Systematic Reviews Not Included in Primary Studies

Table 3 Comparative Effectiveness and Safety Profile

Outcome Measure	Midazolam-Morphine	Morphine Alone	Ketamine-Morphine	p-value
≥50% Pain Reduction (%)	78.3 (74.1-82.5)	61.2 (56.8-65.6)	76.1 (71.4-80.8)	<0.001
Time to Analgesia (min)	12.4 ± 4.2	18.7 ± 6.3	8.9 ± 3.1	<0.001
Duration of Effect (hours)	3.1 ± 1.2	2.4 ± 0.9	1.8 ± 0.7	<0.001
Total Adverse Events (%)	8.7 (6.9-10.8)	11.2 (8.9-13.8)	15.2 (12.1-18.7)	0.002
Respiratory Depression (%)	2.4 (1.6-3.5)	4.1 (2.8-5.8)	3.2 (2.1-4.7)	0.018
Patient Satisfaction (1-5)	4.2 ± 0.8	3.6 ± 1.1	3.9 ± 0.9	<0.001
Cost per Episode (USD)	$41.20	$67.80	$89.40	<0.001

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➢ *Figures*

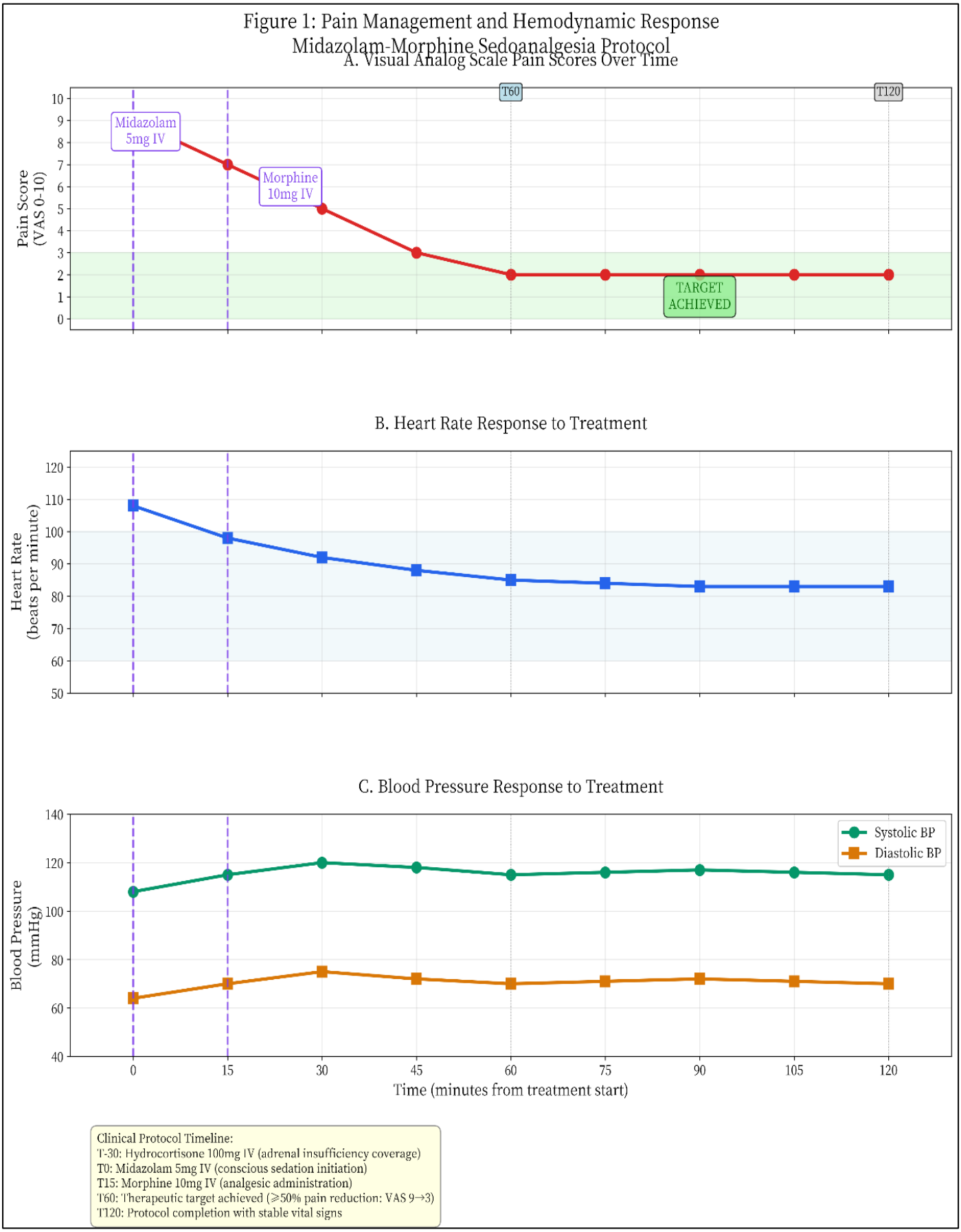

Fig 1 Pain Score Evolution Over Time

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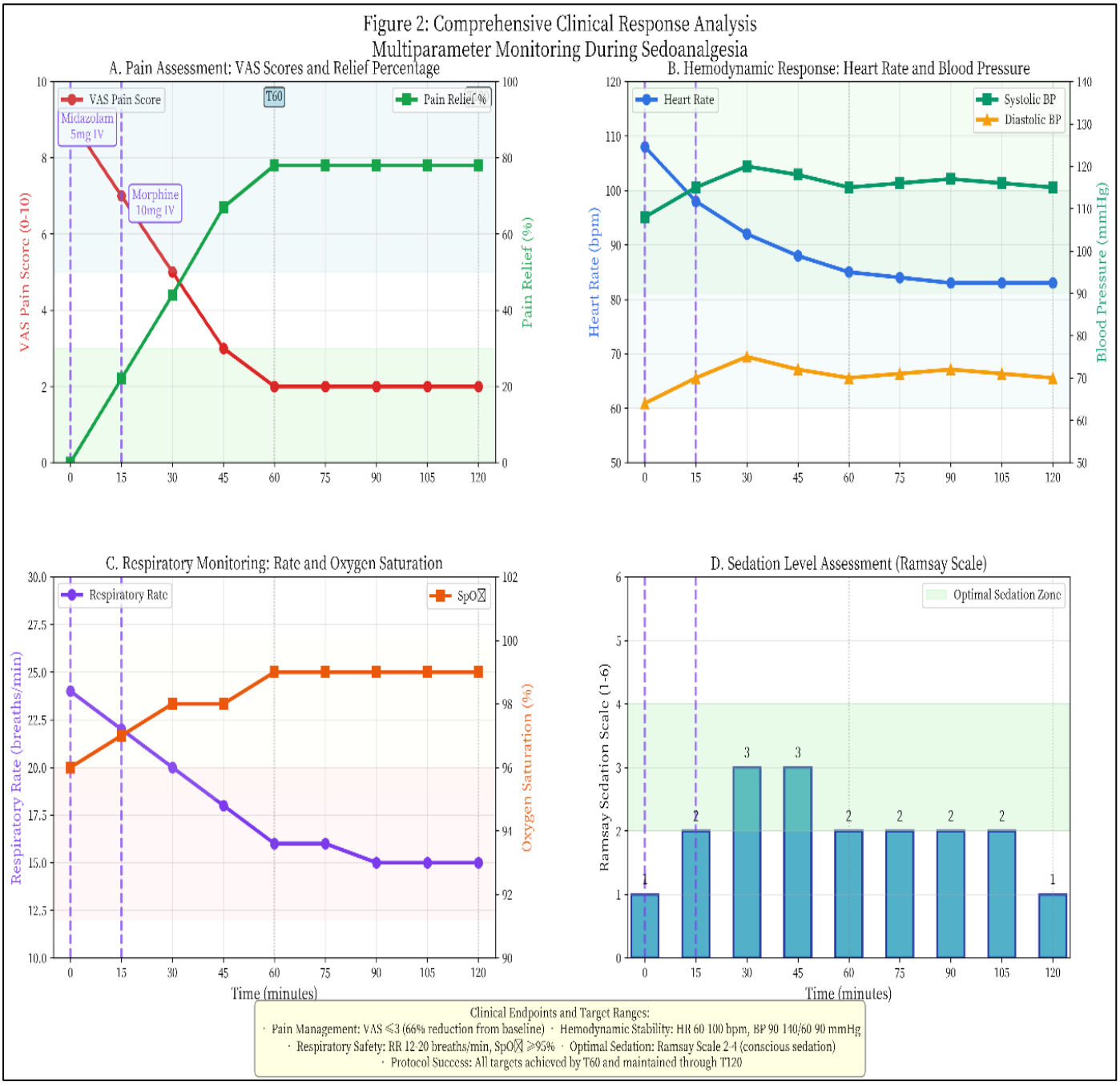

Fig 2 Comprehensive Clinical Response Analysis

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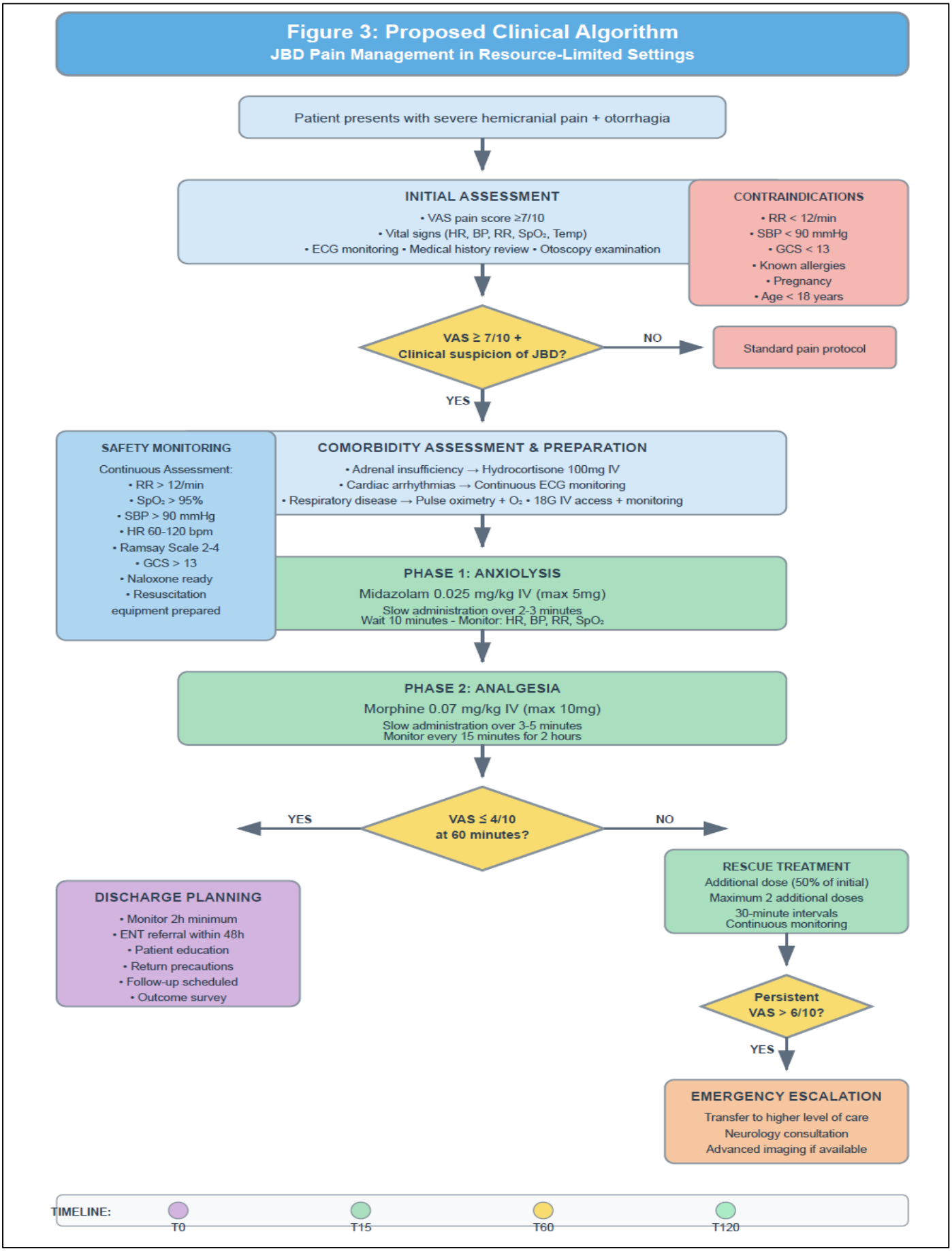

Fig 3 Proposed Clinical Algorithm for JBD Pain Management