Section: Physiology & Anaesthesia

Systematic Review Article

# AUTONOMIC MARKERS (HRV) AS PREDICTORS OF HYPOTENSION AND RECOVERY QUALITY IN REGIONAL ANAESTHESIA: A SYSTEMATIC REVIEW

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**ABSTRACT**

**Background:** Spinal anaesthesia induced hypotension (SAIH) is a frequent and important complication of regional anaesthesia, especially in elective caesarian deliveries and major orthopaedic surgery. The mechanism effect is sympathetic blockage, resulting in hemodynamic instability. **Objectives:** This is a study of the role of Heart Rate Variability (HRV) as a predictive marker of hypotension during spinal and general anaesthesia. Specifically, it addresses the question of if high baseline sympathetic tone or low autonomic reserve is the main predictor of develop hypotension, and to evaluate the role of HRV in the quality of post-operative recovery.
**Methods and Materials:** A thorough systematic search of PubMed, EMBASE, Cochrane Library, Web of Science, and Scopus was performed, which were interested in studies that assessed HRV as a predictor of hypotension during spinal or general anaesthesia. The search was based on prospective observational studies, diagnostic accuracy studies and randomized controlled trials with a focus on HRV parameters such as LF/HF ratio, SDNN, RMSSD and Total Power.
**Results:** A total of 16 studies were included in the analysis based on the inclusion criteria. High baseline sympathetic tone (elevated LF/HF ratio) was found to be a significant predictor of hypotension in spinal anaesthesia. In accordance, low autonomic reserve (low Total Power) was found to predict hypotension in general anaesthesia. Additionally, dynamic monitoring of HRV, postural change and intra-operative, predicted more accurate hypotension than static HRV baselines especially in complex patient populations with comorbidities.
**Conclusion:** HRV is a good predictor of a drop in blood pressure (hypotension) in spinal anaesthesia as well as general anaesthesia, and the risk profile differs according to anaesthesia type.
**Keywords:** Heart Rate Variability, Spinal Anaesthesia, Hypotension, General Anaesthesia, Autonomic Nervous System, Recovery Quality, Predictive Biomarkers.

## INTRODUCTION

Spinal anaesthesia is the anaesthetic of choice for caesarian section and major lower limb orthopaedic surgery because of the rapid onset, reliability and lack of manipulation of the airway. However, despite its ubiquity, spinal anaesthesia-induced hypotension (SAIH) is the most common and vexing complication with reported incidence rates as high as 80% in obstetric populations [Jendoubi et al., 2020]. The hemodynamic mechanism is well-understood: the intrathecal injection of local anaesthetic causes a rapid and profound sympathetic blockage with associated peripheral vasodilation, venous pooling and a subsequent decrease in cardiac output [Bishop et al., 2017]. If it is not treated, SAIH can lead to serious pregnancy symptoms like nausea and vomiting, long hospital stay, and poor foetal outcomes like acidosis and low Apgar scores [Sakata et al., 2016].

Current clinical practice is based to a large extent on prophylactic strategies that have been used empirically - such as co-loading of fluids and fixed rate vasopressor infusions - rather than based on a personalised risk stratification. A non-invasive approach for accurately predicting the susceptibility of an individual patient to hypotension prior to induction would enable the optimization of hemodynamic management for that patient [Higashi et al., 2025]. Heart Rate Variability (HRV), the interval between the times of subsequent heartbeats, has gained popularity as a procedure to test the integrity and autonomic balance of the autonomic nervous system (ANS).

The usefulness of HRV as a prognostic biomarker is already well-established in neuro-critical care, in which autonomic dysfunction is a hallmark of severe physiological stress. In patients with aneurismal subarachnoid haemorrhage (aSAH), depressed HRV (especially low SDNN) and low baroreflex sensitivity have been shown to be independent predictors of mortality [Uryga et al., 2018]. Similarly, in acute intracerebral hemorrhage (ICH), low HRV complexity (Multiscale Entropy) is associated with hematoma expansion and poor functional outcome [Chen et al., 2018; Szabo et al., 2018]. Furthermore, certain autonomic patterns have been associated with secondary complications: Swor et al (2019) showed that admission HRV predicted development of neurogenic fever whilst Schmidt et al (2014) and Su et al (2009) showed the loss of HRV variability preceded the onset of delayed cerebral ischemia and vasospasm by up to 24 hours. These results confirm that the presence of a "rigid" or "low-variability" autonomic system is a sign of systemic failure in the setting of catastrophic brain injury.

However to translate this "Low HRV = Bad Outcome" paradigm to regional anaesthesia has proven complex. Unlike the pathological autonomic failure caused by stroke, the hemodynamic instability of spinal anaesthesia is a pharmacological event. Consequently, a large body of literature exists and there is a major conflict as to which autonomic pattern indicates risk. One school of thought (pioneered by Hanss et al. 2006 and validated by Bishop et al. 2017 and Shehata et al. 2019), suggests that the most vulnerable patients are those with High Baseline Sympathetic Tone (elevated LF/HF ratio). The mechanism postulated is that these patients have been working very hard to keep their vascular resistance up by relying heavily on high sympathetic drive, and when the spinal block breaks this drive they suffer a devastating loss of pressure. This "High Tone" hypothesis has been supported even for general surgical populations [Okanlawon et al., 2022] and correlates with increased vasopressor requirements [Prashanth et al., 2016].

In direct contrast, literature based on general anaesthesia populations - such as by Hanss et al. (2008), Huang et al. (2006) and Padley et al. (2017) - suggests that Low Autonomic Reserve (depressed Total Power) is the main predictor of hypotension mirroring the "frailty" model as in neuro-critical care. Complicating this picture further, studies that have been carried out involving patients with comorbidities, e.g. hypertension (Kweon et al., 2013) or high pre-operative anxiety (Yokose et al., 2015), have found non-predictive static HRV baselines.

**Figure 1: Sympathetic Tone Mechanism in Spinal Anaesthesia**

This diagram illustrates how high baseline sympathetic tone leads to hypotension during spinal anaesthesia. The left section shows a patient with elevated sympathetic tone (high LF/HF ratio). The middle section depicts sympathetic blockade from the spinal anaesthesia, causing vasodilation and venous pooling. The right section highlights the resulting hypotension, characterized by low blood pressure, bradycardia, and reduced oxygen delivery to tissues.

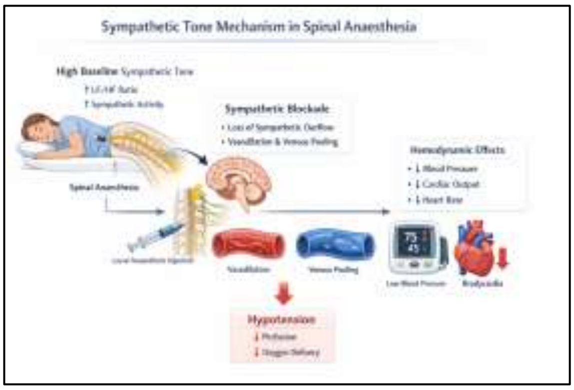


**Figure 1: Sympathetic Tone Mechanism in Spinal Anaesthesia**

This systematic review aimed to resolve these conflicts by assessing the diagnostic accuracy of HRV parameters to predict hemodynamic instability. In particular, it aims to investigate whether the risk for hypotension is determined by High Sympathetic Tone (susceptibility to blockade) or Low Autonomic Reserve (inability to compensate), and how this relationship is different for spinal and general anaesthesia. Furthermore, we assess the link between HRV and quality of post-operative recovery in order to establish whether autonomic profiling is of value beyond the operating theatre [Ernst et al., 2017; May et al., 2019].

## MATERIALS AND METHODS

**Protocol and Registration** This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.

**Search Strategy** A systematic search strategy was developed to determine prospective observational studies, and diagnostic accuracy studies of the predictive utility of Heart Rate Variability (HRV) in anaesthesia. The following electronic databases were searched from inception to February, 2026: PubMed (MEDLINE), EMBASE, The Cochrane Library (CENTRAL), Web of Science and Scopus.

The search strategy utilized a combination of Medical Subject Headings (MeSH) and free-text terms including: "Heart Rate Variability," "Autonomic Nervous System," "Spinal Anesthesia," "Epidural Anesthesia," "General Anesthesia," "Hypotension," "Bradycardia," and "Hemodynamic Instability." The reference lists of included articles were manually screened to identify additional relevant studies.

**Inclusion Criteria:**

**Population:** Adult patients (≥18 years) undergoing elective or emergency surgery.

**Intervention:** Neuraxial blockade (Spinal/Epidural) or General Anaesthesia.

**Predictor:** Pre-operative or intra-operative measurement of HRV using standard Time-Domain (e.g., SDNN, RMSSD) or Frequency-Domain (e.g., LF, HF, LF/HF ratio, Total Power) parameters.

**Outcome:** The primary outcome was the incidence of intra-operative hypotension (as defined by the individual study). Secondary outcomes included bradycardia, vasopressor requirements, and post-operative recovery quality (e.g., complications, myocardial injury).

**Study Design:** Prospective observational studies, diagnostic accuracy studies, and randomized controlled trials.

**Exclusion Criteria:**

**Acute Neurological Injury:** Studies involving patients with acute brain injury (e.g., Subarachnoid Hemorrhage, Intracerebral Hemorrhage, Traumatic Brain Injury) were strictly excluded. In these populations, autonomic dysfunction is a marker of primary pathology and mortality (e.g., "autonomic storm"), which is mechanistically distinct from the pharmacological susceptibility to anaesthesia.

**Pediatric Populations:** Patients <18 years of age.

**Animal Studies, Case Reports, and Reviews.**

**Intervention-Only Studies:** Studies evaluating HRV as an outcome of a drug intervention without correlating it to hemodynamic stability (unless a predictive arm was included).

**Data Extraction**

Two independent reviewers screened the titles and abstracts for relevance followed by retrieving full-text articles and evaluating them against predefined inclusion criteria. Data were extracted using a standardized, pilot-tested form to ensure that there is consistency and accuracy in the data collection methods across the studies. Extracted information consisted of study characteristics (first author, year of publication, country, study design and sample size), population characteristics (type of surgery (obstetric or general) and relevant comorbidities [preeclampsia, hypertension and diabetes mellitus]), anaesthesia protocol (type of anaesthesia given, drug dosages, and perioperative fluid management) and heart rate variability (HRV) methodology (monitoring device used, timing of HRV data recording (static pre-operative versus dynamic intra-operative) and specific parameters analysed, including low-frequency/high-frequency ratio, total power and Analgesia Nociception Index). Outcome measures included the definition of hypotension (e.g. systolic blood pressure < 90mmHg or a percentage reduction from baseline), incidence of hypotension, diagnostic accuracy indicators such as sensitivity and specificity and effect estimates such as odds ratios.

**Quality Assessment**

The methodological quality of included observational studies was evaluated by using the Newcastle-Ottawa Scale (NOS). This tool assesses studies on three domains: selection of study groups, comparability of groups, and ascertainment of the outcome. Studies were rated as having low, moderate or high risk of bias according to these criteria. Diagnostic accuracy studies were evaluated for applicability and bias for the QuADAS-2 (Quality Assessment of Diagnostic Accuracy Studies).

**Data Synthesis**

Due to a large heterogeneity in the recording method of HRV (short-term vs. Holter), parameter definition (Time vs. Frequency domain), and hypotensive threshold (absolute vs. relative drops), quantitative meta-analysis was not possible. Instead, a narrative synthesis was done. Studies were grouped according to anaesthetic technique (Spinal vs. General) in order to allow for a mechanistic comparison. Results were summarised in order to highlight conflicting predictive patterns ("High Tone" vs. "Low Reserve") and the effect of dynamic vs. static monitoring.

## RESULTS

**Study Selection and Characteristics**

A comprehensive literature search was conducted from electronic databases, such as PubMed, Embase, Scopus, and Web of Science, and a total of 926 records were identified. After removing duplicate records (292), 634 studies were available for screening of titles and abstracts. Of these, 596 records were excluded on the basis of predefined eligibility criteria. Subsequently, 38 full-text reports were retrieved and evaluated for eligibility. During full-text evaluation, studies were excluded due to these primary reasons: focus on acute neurological injury (n=10), intervention only study design with no relevant outcome measures (n=8), pediatric population (n=4), and other methodological/population-related exclusions.

Following the eligibility evaluation, a total of 16 studies met the eligibility and were included in the final qualitative synthesis in this review.

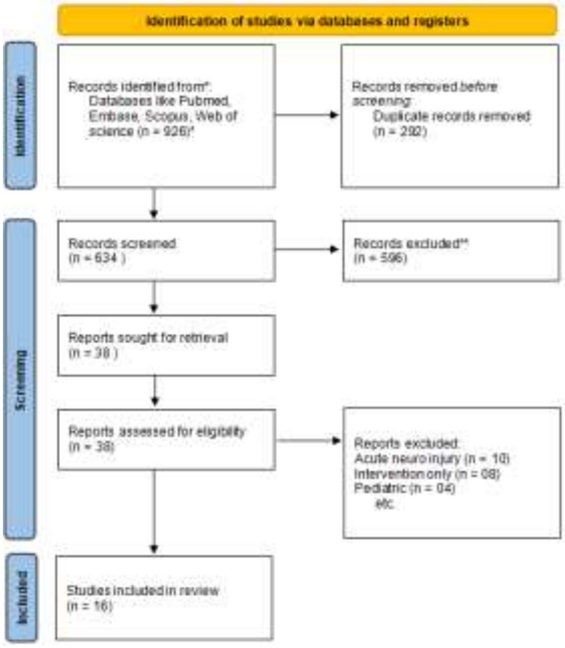

**Figure 2: PRISMA flowchart**

### Prediction of Hypotension in Spinal Anaesthesia

The association between pre-operative static HRV and spinal anaesthesia-induced hypotension (SAIH) was the main outcome in nine studies. The results show a distinct "High Sympathetic Tone" risk profile though this was affected by patient comorbidities.

### The "High Sympathetic Tone" Risk Factor

Five of the studies found high pre-operative sympathetic tone to be an important predictor of hypotension. Hanss et al. (2006) presented the first evidence in a group of 100 elective caesarean sections. They showed that patients with a pre-operative LF/HF > 2.5 showed a much larger decrease in systolic blood pressure (to 66% of baseline) than those with low sympathetic tone (91% of baseline, P < 0.001) [Hanss et al., 2006].

This finding was confirmed by Bishop et al. (2017) who found that an LF/HF ratio greater than 2.0 was an independent predictor of hypotension (Odds Ratio 1.48; 95% CI 1.05-2.12) [Bishop et al., 2017]. Shehata et al. (2019) expanded this to high-risk populations and reported that in cases of preeclampsia in parturients, an LF/HF ratio > 2.5 was predictive of hypotension with a sensitivity of 92.6% and specificity of 90.9% [Shehata et al., 2019]. Prashanth et al. (2016) also found that a high "ANSindex" (which indicates a dominance of sympathetic activity) was associated with higher needs for vasopressors [Prashanth et al., 2016]. Recently, Okanlawon et al. (2022) have validated this mechanism in a general surgery population with hypotensive patients having significantly higher pre-operative Low Frequency (LF) power (358 $ms^2$ vs. 198 $ms^2$, P=0.02) [Okanlawon et al., 2022].

### Influence of Comorbidities

On the other hand, in studies conducted in populations with chronic autonomic suppression, limited predictive value was found for static HRV. Yokose et al. (2015) concluded that pre-operative HRV parameters were a poor predictor of hypotension for elective Caesarean sections because simple baseline heart rate was a better predictor [Yokose et al., 2015]. Similarly, Kweon et al. (2013) conducted a study in hypertensive patients on medication and showed that they did not find any significant correlation between baseline HRV and hypotension, which might suggest that chronic antihypertensive medication could have a blunting effect on the autonomic variability needed to stratify risk [Kweon et al., 2013].

**Table 1: Studies Evaluating Static Baseline HRV for Hypotension in Spinal Anaesthesia**

| Author (Year) | Population (n) | Anaesthesia | Predictor Metric | Hypotension Definition | Key Findings & Statistics | Interpretation |
|---|---|---|---|---|---|---|
| Hanss et al. (2006) | 100 Elective C-Section | Spinal | LF/HF Ratio | SBP drop > 20% | LF/HF > 2.5 predicted severe hypotension with Sensitivity 85% and Specificity 90% (P<0.001). | High Sympathetic Tone is the primary risk factor. |
| Bishop et al. (2017) | 102 Elective C-Section | Spinal | LF/HF Ratio | SBP < 100 mmHg | LF/HF > 2.0 was an independent predictor of hypotension (Odds Ratio 1.48; 95% CI 1.05–2.12). | Validates the "High Tone" risk model. |
| Shehata et al. (2019) | 60 Preeclamptic C-Section | Spinal | LF/HF Ratio | SBP drop > 25% | LF/HF > 2.5 strongly predicted hypotension (AUC 0.965). Sensitivity 92.6%, Specificity 90.9%. | Confirms risk extends to preeclamptic patients. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Prashanth et al. (2016) | 108 Elective C-Section | Spinal | ANSindex (Sympathetic Tone) | SBP drop > 20% | Patients with High ANSindex had significantly higher incidence of hypotension and vasopressor use (P<0.01). | High sympathetic tone correlates with vasopressor need. |
| Okanlawon et al. (2022) | 84 General Surgery | Spinal | LF Power (ms2) | SBP drop > 20% | Hypotensive patients had significantly higher Pre-op LF Power (358 vs 198 ms2, P=0.02). | Extends "High Tone" finding to general surgery patients. |
| Yokose et al. (2015) | 81 Elective C-Section | Spinal | LF/HF Ratio & Entropy | SBP < 90 mmHg | HRV parameters failed to predict hypotension. Baseline Heart Rate was the only predictor (OR 1.06). | Negative Study: Static HRV may be confounded by anxiety. |
| Kweon et al. (2013) | 41 Hypertensive Patients | Spinal | LF/HF & Total Power | MAP drop > 20% | No significant correlation found between baseline HRV and hypotension (P>0.05). | Negative Study: Chronic hypertension/meds may blunt HRV predictive value. |

These studies investigate whether a single resting measurement of HRV can predict hypotension. Note the consensus on "High Sympathetic Tone" in obstetric populations versus the "Null" findings in comorbid populations. [Table 1]

**Table 2: Studies Evaluating Dynamic or Provocation HRV Tests**

| Author (Year) | Population (n) | Method | Predictor Metric | Key Findings & Statistics | Interpretation |
|---|---|---|---|---|---|
| Sakata et al. (2016) | 45 Elective C-Section | Pre-operative Provocation: Postural Change Test (Supine → Left Lateral) | Change in LF/HF Ratio | Patients with a "Positive" postural test (significant HRV change) had higher hypotension risk. AUC 0.76. | Autonomic Reactivity (instability) is a superior predictor to resting tone. |
| Jendoubi et al. (2020) | 100 Elective C-Section | Intra-operative Dynamic: Monitoring immediately post-spinal | Drop in ANI (Analgesia Nociception Index) | A drop in ANI > 4.5 points within 10 mins of block predicted hypotension (Sensitivity 75%, Specificity 67%). | The magnitude of sympathetic withdrawal reflects the hemodynamic crash. |

These studies address the limitations of static baselines by measuring the autonomic response to a stressor (posture change) or the anaesthetic block itself. [Table 2]

**Table 3: Mechanistic Contrast – General Anaesthesia & Recovery Outcomes**

| Author (Year) | Population (n) | Anaesthesia | Predictor Metric | Key Findings & Statistics | Mechanism Implication |
|---|---|---|---|---|---|
| Hanss et al. (2008) | 100 High-Risk (Cardiac/Vascular) | General | Total Power (TP) | Low TP (< 500 ms2) predicted hypotension with Sensitivity 81% (P<0.05). | Low Autonomic Reserve (Frailty) prevents compensation for vasodilation. |
| Huang et al. (2006) | 133 Diabetic & Non-Diabetic | General | Total Power (TP) | High Total Power was protective (Odds Ratio 0.15 for hypotension). | Confirms that autonomic neuropathy (Low HRV) drives instability in GA. |
| Padley et al. (2017) | 55 Major Abdominal | General | SDNN & Sample Entropy | Hypotensive patients had significantly Lower SDNN (16 vs 37ms, P<0.001) and Lower Complexity. | Rigid/Frail ANS cannot adapt to induction agents. |
| Boyle et al. (2021) | 47 Cervical Myelopathy | General | Total Power (TP) | Low TP predicted post-induction hypotension with Sensitivity 82%. | Neurologic autonomic dysfunction leads to hemodynamic instability. |

| | | | | | |
|---|---|---|---|---|---|
| Dinesh et al. (2023) | 60 Diabetic Patients | General | SDNN & LF/HF | Diabetic patients (Low HRV) had 30% hypotension incidence vs 6% in controls. | Diabetes-induced autonomic failure increases induction risk. |
| Ernst et al. (2017) | 190 Geriatric Hip Fracture | Regional/GA Mixed | SDNN & VLF | Low HRV predicted postoperative complications (delirium, cardiac events). | Low HRV is a universal marker of poor physiological resilience. |
| May et al. (2019) | Non-Cardiac Surgery Cohort | General | Heart Rate Recovery | Vagal Dysfunction (delayed recovery) associated with Myocardial Injury (MINS). | Vagal failure predicts organ injury. |

These studies demonstrate the "Mechanism Flip": unlike spinal anaesthesia, Low HRV (frailty) is the risk factor under general anaesthesia. [Table 3]


**Figure 3: Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2)**

Risk of bias was assessed using the QUADAS-2 tool. Five studies showed a low risk of bias across all domains, utilizing consecutive patient enrollment and pre-specified HRV thresholds. Two studies (Sakata et al., Okanlawon et al.) were graded as 'Some concerns' in the patient selection domain due to insufficient reporting of sampling methods. [Figure 3]

The overall methodological quality of the included studies was moderate to high quality. Eight studies had a low risk of bias (Newcastle-Ottawa Scale [NOS] score ≥8). The remaining eight studies scored between 6 and 7, with the main reasons for losing points being in the 'Comparability' domain (due to a lack of multivariate adjustment for confounders such as patient anxiety or baseline medication use).

## DISCUSSION

**Overview of Findings**

This systematic review found a specific and context-specific link between pre-operative Heart Rate Variability (HRV) and hemodynamic instability. The data indicate a "Mechanism Flip" according to the anaesthetic technique used. Patients with high baseline SNS (high LF/HF ratio) are the most at risk for hypotension during spinal anaesthesia. Conversely in general anaesthesia the risk profile is inverted patients with low autonomic reserve (depressed HRV) are most vulnerable. This difference underscores the fact that hemodynamic instability is not a homogeneous object, in other words, it is a particular interaction between the patient's autonomic baseline and the pharmacological insult.

**The "High Tone" Risk in Spinal Anaesthesia**

The main hemodynamic insult during spinal anaesthesia is the acute pharmacological sympathectomy of local anaesthetics. Our review confirms the basic findings of Hanss et al. [2006] and Bishop et al. [2017] showing patients with a pre-operative dominance of sympathetic tone (High LF/HF) have the most catastrophic blood pressure drops [Hanss et al., 2006; Bishop et al., 2017].

Physiologically, these "High Tone" patients have a high systemic vascular resistance to maintain their baseline blood pressure. When spinal block cuts off this efferent drive, there is a "drop out" of the vascular floor, there is rapid venous pooling, and hypotension ensues. This mechanism seems to be robust, recognized in preeclamptic parturients by Shehata et al and in general surgical patients by Okanlawon et al. [Shehata et al., 2019; Okanlawon et al., 2022]. Clinically this indicates that the "fit" patient with a high resting sympathetic drive could paradoxically be at a higher risk during spinal anaesthesia than the patient with lower tone.

**The Challenge of Static Baselines: Anxiety and Comorbidities**

While the "High Tone" model is true for healthy populations, we found from our review there were significant confounders in the static pre-operative testing. Yokose et al. (2015) concluded that static HRV did not predict hypotension, probably because of the artificial increase in pre-operative anxiety, which artificially increased SNS [Yokose et al., 2015]. Similarly, Kweon et al. (2013) showed in hypertensive patients that chronic drugs (e.g. Beta-blockers) and vascular stiffness dampened the autonomic signal, making the static HRV non-predictive [Kweon et al., 2013]. These "Negative Studies" emphasize that a single picture of the autonomic nervous system is often not enough to risk stratify the complex or anxious patient.

**The Solution: Dynamic and Provocation Monitoring**

To overcome the limitations of static baselines, there is recent literature in favor of a dynamic autonomic assessment. Sakata et al. (2016) showed that a pre-operative Postural Change Test was able to unmask the presence of autonomic instability that was not apparent at rest. Patients who presented a great HRV change from supine to lateral positions had a significant probability of developing hypotension (AUC 0.76) [Sakata et al., 2016].

Furthermore, Jendoubi et al. (2020) confirmed the usefulness of intra-operative dynamic monitoring. They found that the extent of sympathetic withdrawal (expressed as a decrease in the Analgesia Nociception Index greater than 4.5) immediately after the spinal block was highly predictive of the subsequent hemodynamic crash [Jendoubi et al., 2020]. This supports the concept that the reaction to the anaesthetic insult is a better biomarker than the pre-operative state. Further evidence that seems to align with this paradigm shift and demonstrate the effectiveness of treating dynamic physiological changes (e.g. cardiac output drops) instead of reactive management based on static thresholds can be found in [ Higashi et al. 2025].

**The "Mechanism Flip" in General Anaesthesia**

A major result of this study is the diametrically opposite risk profile under general anaesthesia. Unlike the "High Tone" risk of spinal blockade, instability in the general induction is stimulated by Low Autonomic Reserve (Frailty). Studies by Hanss et al., (2008), Huang et al., (2006) and Padley et al. (2017) have shown that low Total Power and low complexity have been found to be predictors of hypotension [Hanss et al., 2008; Huang et al., 2006; Padley et al., 2017].

In this context, the anaesthetic insult (myocardial depression and vasodilation) calls for the body to mount a compensatory response (e.g. tachycardia). Patients with a "rigid" or "frail" autonomic system (Low HRV) do not have this reserve and do not compensate, resulting in hypotension. This distinction is critical to the clinician: High HRV = Risk for Spinal Anaesthesia (aka "Crash") Low HRV = Risk for General Anaesthesia (aka "Failure")

**Recovery and Long-Term Implications**

Beyond the immediate hemodynamics, the Low HRV is a universal marker of poor physiological resiliency. May et al. (2019) showed that vagal dysfunction (delayed heart rate recovery) was related to perioperative myocardial injury (MINS) [May et al., 2019]. Thus, while a high sympathetic tone may be predictive of intra-operative volatile behavior, low parasympathetic tone is predictive of "slow failure" (poor post-operative recovery).

**Limitations**

The heterogeneity in HRV metrics (Time vs Frequency domain) and hypotension definitions between studies. Additionally we excluded patients with acute neurological injury (e.g. SAH), as autonomic dysfunction in these cohorts has been a marker of primary pathology and mortality and not of anaesthetic susceptibility.

## CONCLUSION

HRV is a useful predictor of hemodynamic instability; however, the concept must be put into perspective. High Pre-operative Sympathetic Tone is a predictor for Hypotension in a Spinal Anaesthetic and Low Autonomic Reserve is a predictor for Instability in General Anaesthesia. Future clinical protocols should favor dynamic monitoring techniques such as provocation testing or real-time intra-operatives to be able to improve the predictive accuracy in the complex patient population.

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