The importance of temporal structure can be explained by the following two sequences: \( A = \{1232123212321\} \) and \( B = \{1111222222333\} \). Both have the same variability, measured by the range and standard deviation, but completely different structures. Sequence \( A \) defines a triangular wave whereas sequence \( B \) is a step function. With advanced technology to capture beat-to-beat BP values and computational methods, the temporal dynamics of the BP waveform could be analyzed easily. BP complexity similar to frailty reflects the physiologic reserve and adaptive responsiveness of the system to stress. Recent evidence reports a significantly lower BP complexity in patients with adverse outcomes. Furthermore, BP complexity indices were found to correlate with standard risk prediction scores. Hence, frailty and complexity could possibly be a surrogate of an individual’s physiological reserve.

Recent evidence suggests autonomic dysfunction could possibly be the underlying mechanism behind frailty and perioperative complications. Being mainly regulated by the autonomic nervous system, blood pressure (BP) variability is significantly affected by autonomic dysfunction. The relationship between BP variability (beat to beat change) independent of the individual BP numbers on perioperative adverse outcomes has gained increased interest recently. Various methods were used to study BP variability. However, these methods do not describe the temporal dynamics of the BP waveform.

An increasing number of elderly patients presenting for surgery has profound implications for perioperative medicine. Around half of the surgeries in the United States were done among elderly patients. Unique physiological changes result in multisystem decline and increase their vulnerability for complications. Frailty expresses this phenomenon and has been considered as a state of decreased physiological reserve and resistance to stressors. Although more common with age, frailty is a distinct concept of biological rather than chronological age. Moreover, the underlying mechanisms of frailty are different from aging. Hence, frailty could explain the observed variations in clinical outcomes that cannot be explained by chronological age alone. Substantial stressor like surgery in frail patients could result in a disproportionate change from independent to dependent, mobile to immobile, stable posture to frequent falls, or lucid to delirious state. Emerging evidence demonstrates increased perioperative complications associated with frailty and incorporating frailty assessment has shown to improve prognostication of existing risk stratification tools. The two widely accepted models of frailty include a phenotypic construct and a deficit accumulation model. However, there is no clear consensus regarding a standard method to assess frailty. Recent evidence suggests autonomic dysfunction could possibly be the underlying mechanism behind frailty and perioperative complications. Being mainly regulated by the autonomic nervous system, blood pressure (BP) variability is significantly affected by autonomic dysfunction. The relationship between BP variability (beat to beat change) independent of the individual BP numbers on perioperative adverse outcomes has gained increased interest recently. Various methods were used to study BP variability. However, these methods do not describe the temporal dynamics of the BP waveform.

The importance of temporal structure can be explained by the following two sequences: \( A = \{1232123212321\} \) and \( B = \{1111222222333\} \). Both have the same variability, measured by the range and standard deviation, but completely different structures. Sequence \( A \) defines a triangular wave whereas sequence \( B \) is a step function. With advanced technology to capture beat-to-beat BP values and computational methods, the temporal dynamics of the BP waveform could be analyzed easily. BP complexity similar to frailty reflects the physiologic reserve and adaptive responsiveness of the system to stress. Recent evidence reports a significantly lower BP complexity in patients with adverse outcomes. Furthermore, BP complexity indices were found to correlate with standard risk prediction scores. Hence, frailty and complexity could possibly be a surrogate of an individual’s physiological reserve. The 2010 National Confidential Enquiry into Patient Outcome and Death from the UK found that frailty was not included in the risk assessment of elderly patients. They recommended to include frailty in perioperative risk assessment. Despite recommendations from major organizations (American Chemical Society, Anesthetic Groups, and Association of Anaesthetists of Great Britain and Ireland), frailty is rarely used in routine perioperative care. Multiple methods are used to assess frailty. Their limitations such as time consumption need for specialized training or evaluation and difficulty with emergency surgeries has
The frail (aging) brain is associated with characteristic age-related changes. Disproportionately affected hippocampal pyramidal neurons [10] and hyper-responsive microglia [11] are proposed to play a role in the pathophysiology of neurocognitive disorders. Post-operative delirium (POD) and post-operative cognitive dysfunction (POCD) are a growing concern among elderly patients. POD is an acute dysfunction with symptoms including disorientation, impairment of attention and memory. POCD is a persistent cognitive disorder that lasts from a few hours to several days or months. Among multiple contributing factors, chronological age is nonmodifiable whereas frailty, pre-operative cognitive function, and neurocognitive reserve were proposed as modifiable [12]. Evidence from literature supports a temporal association between frailty, cognitive decline, delirium, and dementia [13, 14]. Therefore, identifying and targeting interventions toward at-risk patients could help in preventing adverse outcomes.

Predicting operative risk among elderly patients is challenging due to their discrepancies in health status and inadequacy of assessment tools. Commonly used predictors such as American Society of Anesthesiologists score, Charlson Comorbidity Index, and Lee’s cardiac risk index are either subjective or based on organ systems, and none of them actually account for an individual’s physiological reserve. Despite the widespread use of existing tools, complications in the elderly surgical population remain difficult to predict.

To summarize, the elderly patients are assessed based on their medical conditions alone without accounting for their physiological reserve. Incorporating measurements of an individual’s physiological reserve such as (a) frailty based on easily available pre-operative data or (b) complexity derived from pre-operative BP might provide a means for anesthesiologists to identify high-risk patients (Fig. 1). This could be achieved with the help of advancements in health informatics and electronics. With better identification, potential interventions aiming to reduce complications could be accomplished. Prehabilitation is one such intervention which could possibly improve outcomes. A paradigm shift in the pre-operative assessment emphasizing individualized risk is vital and could possibly the future of perioperative medicine.

Surprisingly, no standard method to assess physiological reserve exists. We anesthesiologists often fail to recognize frailty in the perioperative setting. Hubbard and Story in their recent review referred frailty as the “elephant in the operating room: Easy to spot but is often ignored” [15]. Furthermore, the subtler forms of neurocognitive disorders (POD and POCD) may often go undetected resulting in increased morbidities in the elderly patients. These disorders often result from an acute insult on a vulnerable patient. Patients with frailty, a validated marker for vulnerability could possibly be at an increased risk for developing these disorders.

To summarize, the elderly patients are assessed based on their medical conditions alone without accounting for their physiological reserve. Incorporating measurements of an individual’s physiological reserve such as (a) frailty based on easily available pre-operative data or (b) complexity derived from pre-operative BP might provide a means for anesthesiologists to identify high-risk patients (Fig. 1). This could be achieved with the help of advancements in health informatics and electronics. With better identification, potential interventions aiming to reduce complications could be accomplished. Prehabilitation is one such intervention which could possibly improve outcomes. A paradigm shift in the pre-operative assessment emphasizing individualized risk is vital and could possibly the future of perioperative medicine.

References

Conflict of Interest: Nil
Source of Support: None


How to Cite this Article