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ORIGINAL ARTICLE

Predicting hospital outcomes with the reported edmonton frail scale-Thai version in orthopaedic older patients

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Abstract

Aims and objectives: To test the ability of the Reported Edmonton Frail Scale-Thai version to predict hospital outcomes compared with standard preoperative assessment measures (American Society of Anesthesiologists physical status classification and the Elixhauser Comorbidity Measure) in older Thai orthopaedic patients.

Background: Frailty is a common geriatric condition. No previous studies have assessed frailty among orthopaedic patients in Thailand. Effective frailty screening could enhance quality of care.

Design: Prospective cohort study in a university hospital.

Methods: Two hundred hospitalised patients, aged 60 years or older and scheduled for orthopaedic surgery, participated in the study. Frailty was evaluated using the Reported Edmonton Frail Scale-Thai version. Multiple Firth logistic regression was used to model the effect of frailty on postoperative complications, postoperative delirium and discharge disposition. Length of stay was examined using Poisson regression. Comparing predictability of the instruments, the area under the receiver operating characteristic curve and mean squared errors were evaluated. The STROBE guideline was used.

Results: Participants' mean age was 72 years; mostly were female, frail and underwent knee, spine and/or hip surgery. Poor health outcomes including postoperative complications, postoperative delirium, and not being discharged to the home were commonly identified. The length of stay varied from three days to more than ten weeks. Frailty was significantly associated with postoperative complications, postoperative delirium and prolonged length of stay. The Reported Edmonton Frail Scale-Thai version revealed good performance for predicting postoperative complications and postoperative delirium and was improved by combining with standard assessments.

Conclusion: The Reported Edmonton Frail Scale-Thai version, alone or combined with standard assessment, was useful for predicting adverse outcomes in older adults undergoing orthopaedic surgery.

Relevance to clinical practice: These findings indicate that nurse professionals should apply culturally sensitive frailty screening to proactively identify patients' risk of frailty, improve care quality and prevent adverse outcomes.

KEYWORDS
frail elderly, frailty, geriatric assessment, hospitals, instruments, older adults, orthopaedic surgery, patient care, postoperative complications, quality of care

1 | INTRODUCTION

In ageing societies, promoting healthy ageing alongside improving quality of care is an important goal (Briggs et al., 2016). Therefore, promoting early detection of decline and delaying the onset of the loss of independence are high priorities for orthopaedic and geriatric care. Musculoskeletal (MSK) conditions are common comorbidities in older adults, impacting patients' quality of life. The development of MSK conditions is strongly related to increased age and can result in disability with higher disability-adjusted life years (DALYs) (Briggs et al., 2016; Briggs & Dreinhofer, 2017). Specific MSK conditions, such as rheumatoid arthritis (RA), osteoarthritis (OA), osteoporosis, as well as musculoskeletal pain, significantly impact the health of individuals as well as the costs associated with care (Briggs & Dreinhofer, 2017; Cross et al., 2014). Surgical intervention is a treatment option for certain MSK conditions to regain functional ability in older adults, although there are risks and benefits of surgery. Although some postoperative complications are preventable, in-hospital adverse events and unwanted surgical outcomes are still widely reported in orthopaedic surgery, even for simple procedures (Flexman et al., 2016; Ondeck, et al., 2018). Recent studies have suggested that age-related decline (i.e., "frailty") is a significant factor intensifying the risk of developing adverse postoperative outcomes (Birkelbach et al., 2019; Buigues et al., 2015; Cunha et al., 2019). Early identification is the best method, not only for preventing adverse outcomes, but also for enhancing the quality of life in individuals who are frail or at risk of frailty (Cunha et al., 2019; Dent et al., 2016; Theou et al., 2018). However, identifying frailty in hospital settings (i.e., clinical frailty) can be difficult, particularly in low-to-middle-income countries. Difficulty in frailty assessment is commonly related to variation in concepts of frailty, inequality of knowledge about frailty, complexity of instruments for measuring frailty, the time-consuming nature and resource requirements of frailty assessment methods, and inaccessibility of frailty instruments (Dent et al., 2016; Theou et al., 2018). Hence, a valid clinical frailty instrument that can be easily implemented with few requirements and rapid screening would be beneficial for clinicians and healthcare personnel conducting frailty screening in hospital settings. Although research related to frailty has recently received increasing interest in many countries, no previous studies have examined frailty among Thai orthopaedic patients. This population may be at an increased risk of poor health outcomes due to surgical complications and a lack of frailty assessment. To bridge these gaps, it is essential to implement practical frailty assessment measures for promoting health and providing equity of care in this population.

What does this paper contribute to the wider global clinical community?

- This paper provides unique information about frailty assessment and its relationship with adverse surgical outcomes in orthopaedic patients.
- This paper promotes the roles of nurses and orthopaedic nurse specialists in implementing preoperative frailty screening into clinical practice guidelines for promoting health and providing efficient surgical care for older patients.
- This paper demonstrates that combining practical frailty instrument with standard preoperative assessment can improve the ability to predict postoperative complications, postoperative delirium, discharge disposition and prolonged length of stay.

2 | BACKGROUND

As lifespan continues to increase in ageing populations, living with disability or dependency is a significant concern for promoting health and quality of life in older adults (Briggs et al., 2016; Briggs & Dreinhofer, 2017). Previous studies have reported that noncommunicative diseases, particularly musculoskeletal (MSK) conditions, can cause clinically significant suffering, disability, loss of productivity and diminish the quality of life in the ageing population (Briggs & Dreinhofer, 2017; Cross et al., 2014). The impact of specific MSK conditions such as rheumatoid arthritis (RA), osteoarthritis (OA) and osteoporosis on both individual and global health are important considerations for healthcare systems internationally (Briggs et al., 2016; Briggs & Dreinhofer, 2017). Most MSK conditions are treatable, and physical function can be restored with surgical treatment. However, surgery may not lead to the recovery of full function because surgical complications can cause impairment. Complications or adverse events during surgical treatment play a significant role in predicting functional recovery (Aitken et al., 2017). More severe

adverse events or complications are associated with more suffering on multiple dimensions of health, leading to increased length of stay (LOS) and cost of care (Healy et al., 2016). The best management approach for preventing surgical complications is to be well-prepared for patient care by addressing risk factors of poor health outcomes. However, in older adults, age-related changes can increase the difficulty of identifying risk factors and providing better care. Recent evidence has highlighted the importance of managing age-related changes in frailty for providing better care in older populations (Cesari & Vellas, 2015; Dent et al., 2016; Theou et al., 2018). Thus, improving care via the clinical management of frailty at the individual level is critical for professional health personnel.

Frailty is a contributing factor for increased risk of the development of postoperative complications (Lin et al., 2016; Sieber, 2017). Frailty involves increased vulnerability and susceptibility to stressors as well as reduced ability to sustain homeostasis and is related to adverse surgical outcomes (Cesari & Vellas, 2015; Lin et al., 2016; Sieber, 2017). Frail older adults suffering from MSK conditions have a higher risk of postoperative complications, disability, fall-related injury, mortality and readmission compared with those without frailty (Ali et al., 2016; Ondeck, et al., 2018). Preoperative frailty screening plays a key role in preventing adverse outcomes and improving the quality of care. However, detecting frailty in MSK conditions is challenging. Previous studies have highlighted the concern that the main characteristics of MSK conditions, including physical limitations to accomplish activities of daily living, severe pain, joint stiffness, chronic fatigue and sarcopenia, can cause misclassification of frailty status (Beaudart et al., 2015; McGuigan et al., 2017). Until recently, there has not been clear evidence regarding a gold standard to screen for frailty, and frailty instruments are not available in all languages (Dent et al., 2016; Theou et al., 2018). Thus, the development of reliable and culturally adapted instruments is important for accurately measuring frailty and identifying the risk of adverse outcomes in different countries and geographical areas.

In Thailand, no published studies have investigated frailty in orthopaedic patients. The increased prevalence of MSK conditions adversely impacts the health of older adults (Cooper et al., 2016; Gleason et al., 2017; Ondeck, et al., 2018). Because orthopaedic surgery may be an acute stressor which triggers or exacerbates frailty and its downstream processes, early detection of frailty or risk factors for frailty is important to optimise outcomes. To improve quality of care, using a valid instrument to assess frailty may be useful for making clinical decisions and preparing for appropriate preoperative management in frail Thai older adults with MSK conditions. The Reported Edmonton Frail Scale: Thai version (REFS-Thai) is a validated clinical frailty instrument in hospitalised surgical older patients. The REFS-Thai is reported to be useful for application in clinical settings and takes an average of 7 minutes to complete, without the need for additional equipment or training (Roopsawang et al., 2020). In the current study, we evaluated the predictive ability of the REFS-Thai compared with standard preoperative screening methods (American Society of Anesthesiologists physical status classification [ASA] and the Elixhauser Comorbidity Measure [EMC]) to evaluate frail Thai older adults before undergoing elective major orthopaedic surgery (hip, knee or spine surgery) for postoperative complications, postoperative delirium (POD), LOS and discharge disposition.

3 | METHODS

3.1 | Study design and setting

This was a prospective cohort study, following STROBE guideline (supplementary file-1). Hospitalised older adults scheduled for elective orthopaedic surgery (hip, knee or spine surgery) were recruited from a tertiary care university hospital in Thailand. The aims of the current study were: (1) to assess the ability of the REFS-Thai compared with standard preoperative assessment (ASA scoring and EMC) administered preoperatively to predict the occurrence of postoperative complications (from surgery to hospital discharge), POD and discharge disposition following major orthopaedic surgery, and (2) to assess the ability of the REFS-Thai administered preoperatively to accurately predict LOS compared with the ASA scoring instrument and the EMC in patients undergoing major orthopaedic surgery.

Following Institutional Review Board (IRB) approval, this study was conducted from July–November 2018. Trained research assistants reviewed the daily surgery schedule for patients meeting the study criteria, then approached the patient to discuss study participation. All participants provided written informed consent before engaging in the study procedures. If a participant had a visual impairment, verbal agreement to participate in the study was accepted. Participants were followed from study enrolment until discharge from hospital. Participants could refuse to consent or withdraw their consent at any time without detriment to their surgical care or treatment.

3.2 | Participants

Individuals were eligible to participate in this study if they: were 60 years of age or older; spoke and read Thai; were scheduled for major elective orthopaedic surgery (hip, knee or spine surgery). Exclusion criteria were as follows: undergoing emergency surgery; undergoing minimally invasive surgery; presence of cognitive impairment (assessed using Mini-Cog <3 [Trongsakul et al., 2015]); current psychiatric disorder with ineffective treatment; history of stroke, brain injury or Parkinson's disease; currently bedridden or evidence of severe disabilities (i.e., paraplegia and quadriplegia).

3.3 | Ethics statement and procedures

This study was approved by the IRBs. Following consent, data collection started on the first day of admission and continued through to the day of discharge from the orthopaedic ward.

Day of admission: Participant demographic information, ASA scoring and the EMC were extracted from medical records. Participants completed the self-report REFS-Thai. Delirium screening using the 4 "A"s Test (4AT, Thai version) was evaluated preoperatively by trained research assistants.

Postoperative period to hospital discharge: Data regarding types of surgery, postoperative treatments and postoperative complications were extracted from medical records. Daily delirium screening using the 4AT (Thai version) was assessed by trained research assistants. In cases where the participant was discharged or transferred from the orthopaedic ward for any medical reason, the discharge disposition data were documented. At discharge, total LOS was documented. All participant information extracted from the medical records was performed by either the first author or two experienced master's level orthopaedic nursing research assistants who were trained in the study protocol.

3.3.1 | Measures

Mini-Cog (Thai version)

The Mini-Cog Thai version (Trongsakul et al., 2015) was translated from the original Mini-Cog, which is used for cognitive impairment and dementia screening. The Mini-Cog test is scored in two parts: (a) three-item recall; (b) clock drawing. The total possible score is 5, and a total score of less than 3 indicates that a patient is more likely to suffer cognitive impairment or dementia. Higher scores indicate a lower likelihood of suffering from cognitive impairment or dementia. The Mini-Cog-Thai version has been demonstrated to have good inter-rater reliability (K = 0.80, 95% confidence interval [CI] 0.50–1.00, $p < 0.001$) with positive concurrent validity with the Mini-Mental Status Exam Thai 2002 ($r = 0.47$, 95% CI 0.37, 0.55, $p = 0.007$) (Trongsakul et al., 2015).

The reported Edmonton Frail Scale (REFS)–Thai version (REFS-Thai)

The REFS-Thai, a self-report instrument, was translated from the Reported Edmonton Frail Scale (REFS), which defines frailty using an accumulation deficit model. This tool has previously been validated for use in Thai inpatient settings (Roopsawang et al., 2020). The REFS-Thai evaluates nine domains: general health status, cognitive function, functional independence, continence, medication use, nutrition, mood, social support and self-performance. The total possible score on the REFS-Thai version is 18. Frailty is classified as severe frailty (a score of 12–18), moderate frailty (a score of 10–11), mild frailty (a score of 8–9), apparent frailty (a score of 6–7) and non-frail (a score of 0–5). The REFS-Thai shows good inter-rater reliability (linear weights K = 0.87, $p < 0.001$) when applied by nongeriatric trained individuals. The internal consistency of the REFS-Thai also indicates acceptable reliability (Cronbach's alpha = 0.73).

American Society of Anesthesiologists (ASA) physical status classification

ASA scoring (Sankar et al., 2014) is a subjective assessment of a patient's overall health, categorised into six classes (I to VI). Anesthesiologists assess ASA scoring before administering anaesthesia to assess the risk of anaesthesia and surgery. The ASA score is recorded in the patient's medical records. Classification of the ASA score is as follows: ASA class I: normal healthy patient, ASA class II: patient with mild systemic disease, ASA class III: patient with severe systemic disease, ASA class IV: patient with severe systemic disease that is a constant threat to life, ASA class V: moribund patient who is not expected to survive without the operation. ASA class VI, a patient who has been declared brain-dead. Patients in this class were not included in this study.

The Elixhauser Comorbidity Measure (EMC)

The EMC is an assessment of a patient's significant comorbid conditions or their diagnoses at each admission (van Walraven et al., 2009). The 30 comorbid conditions are each determined as dichotomous (present/absent) and are weighted to predict in-hospital complications and mortality. Total EMC scale scores range from −19 (lesser disease burden) to +89 (higher disease burden). A higher score indicates a higher likelihood of suffering adverse outcomes or a higher mortality rate. In surgical patient populations, including hip replacement surgery, the EMC exhibits good predictive power with integrated discrimination improvement (IDI) for predicting 30-days mortality (c-statistic (c) = 0.750; IDI = 2.37%), 1-year mortality (c = 0.755; IDI = 5.82%), 30-readmission (c = 0.629; IDI = 1.43%) and complications (c = 0.730; IDI = 3.99%) (Mehta et al., 2016).

The Thai version of the 4 "A"s Test (4AT)

The 4AT, Thai version (Kuladee & Prachason, 2016), is a short screening instrument for diagnosing delirium in hospitalised older adults. The 4AT has four components for evaluating delirium and cognitive impairment: alertness, abbreviated mental test-4 (AMT4), attention and acute change or fluctuating course. The total possible score on the 4AT is 12. Scores range from possible delirium and/or cognitive impairment (a score of 4 or above), cognitive impairment (a score of 1–3) and unlikely delirium or severe cognitive impairment (a score of 0; but delirium is still possible if the acute change or fluctuating course information is incomplete). For reliability and validity, the Thai-4AT has been shown to exhibit satisfactory performance for screening delirium with 83.3% diagnostic sensitivity (95% CI = 62.6%–95.3%) and 86.3% specificity (95% CI = 76.3%–93.2%), and a receiver operating characteristic (ROC) area under the curve (AUC) value of 0.92 (Kuladee & Prachason, 2016). The 4AT is simple to apply, even in older adults who are unable to undertake cognitive testing or interviews, and does not require specific training to administer.

3.3.2 | Outcome assessment

Outcomes of this study were obtained from daily charts and medication record review during admission through discharge. POD occurrence was evaluated daily by a research assistant using the 4AT. The total LOS (in days) and discharge disposition (home discharge

versus places other than home) were extracted from medical records. Postoperative complications or adverse events were extracted from medical records. For specific postoperative complications, including respiratory failure, surgical site infection, deep vein thrombosis (DVT)/pulmonary embolism (PE), bleeding, renal insufficiency, stroke, unplanned intensive care unit (ICU) admission and cardiac complication (myocardial infarction, new congestive heart failure, new arrhythmia and heart block), were extracted and verified by ortho-geriatric nurse specialists and orthopaedic surgeons.

3.4 | Data analysis

The baseline demographic characteristics, prevalence of preoperative frailty and rates of postoperative health events were calculated. Logistic regression was used to examine the associations between frailty and postoperative events. The present study aimed to screen preoperative frailty status regardless of the severity of frailty; thus, the 5 classifications of frailty were rearranged into three [nonfrail, apparent frailty and frailty (mild, moderate and severe frailty)]. The ability of the REFS-Thai, ASA and EMC to predict development of postoperative complications, POD and discharge disposition was evaluated using Firth logistic regression. LOS was analysed using robust Poisson regression (Aim 1). Models were adjusted for age, gender, type of surgical procedures and comorbidity. Cross-validation of a predictive model based on standard assessment methods (ASA classification and EMC) with and without the REFS-Thai, and the AUC values from the ROC curves were examined for binary outcomes, and cross-validation comparing mean squared error (MSE) values was investigated for LOS (Aim 2). Considering predictive power, AUC values ranged from 0 to 1.0. An AUC value of 0.5 is equal to chance, 0.5–0.6 indicates a failed test, 0.6–0.7 indicates a poor test, 0.7–0.8 indicates a fair test, 0.8–0.9 indicates a good test, and 0.9–1.0 indicates an excellent test (Menendez et al., 2014). Considering MSE cross-validation, a lower MSE score indicates a better prediction model of the outcome variable (LOS). A *p*-value less than .05 was considered as the level of significance for all analyses. The sensitivity, specificity, positive predictive values (PPV), and negative predictive value (NPV) of the instruments—REFS-Thai, ASA and EMC—were analysed for evaluating clinical screening performance. RStudio version 3.5.1 was used for statistical analysis.

4 | RESULTS

A total of 203 hospitalised older adults who were scheduled for orthopaedic surgery agreed to participate in the study. Of these, three participants were excluded from the analysis due to the cancellation of their surgeries. Thus, 200 participants were included in the final analysis (Table 1). The majority of participants were female, with a mean age of 72 years (range 60-94 years). Most participants were nonfrail (n = 114, 57%), and most were retired/not working (n = 160, 80%). On average, the REFS-Thai assessment was completed within 5 minutes.

4.1 | Clinical characteristics of participants and outcomes

Most participants were pre-obese and had moderate-to-severe systemic diseases with preoperative ASA class of III and IV (n = 127, 63.5%) and the average EMC score was 0 (SD =5.12) (See Table 1). Preoperatively, most participants experienced mild pain and no cognitive impairment at admission. Knee surgery was the most common surgery (n = 116, 58%). The average LOS was less than 7 days (range 3–84 days), and approximately 10% (n = 22) of the participants were discharged to other health care facilities. Postoperative complications or life-threatening events occurred in 27% of participants (n = 53). The most common complications and adverse events were respiratory failure requiring intubation (24.5%), neurogenic bladder (22.6%), urinary tract infection (UTI) (20.8%), pressure ulcer (18.9%) and unplanned ICU admission (13.2%) (Appendix: Supplement 1). Notably, one participant who was preoperatively assessed as frail died on the fourth day after hip surgery. POD was identified in 12.5% of participants (n = 25); of these individuals, 52% (n = 13/25) developed delirium at 24-hours after surgery, and 48% (n = 12/25) experienced delirium at the time of discharge. There was no significant association between preoperative health evaluation (ASA class and EMC score) and postoperative complication, POD, discharge disposition or longer LOS.

4.2 | Impact of preoperative frailty on outcomes

Approximately 20% of participants (n = 46, 23%) were frail at preoperative assessment. Compared with the nonfrail group and without controlling for other variables, frailty significantly increased the risk of developing postoperative complications (odds ratio [OR] =5.01, 95% CI: 2.40–10.72), POD (OR = 7.21, 95% CI: 2.57–22.84) and prolonged LOS (relative risk [RR] =1.63, 95% CI: 1.23–2.15), while apparent frailty participants were more likely to develop POD (OR = 5.20, 95% CI: 1.69–17.34). Importantly, there was no significant association between frailty status and discharge disposition (Table 2).

In the multiple Firth logistic regression model, the impact of preoperative frailty on outcomes was analysed, adjusting for age, gender, type of surgery and comorbidity (Table 2). Compared with nonfrail participants, controlling for age, gender, type of surgery and comorbidity (Table 2), frail participants were 2.38 times more likely to develop postoperative complications (OR = 2.38, 95% CI: 1.00–5.64), while apparent frailty participants were 18% less likely to develop postoperative complications (OR = 0.82, 95% CI: 0.30–2.10). For POD, the apparent frailty (OR = 3.75, 95% CI: 1.14–13.15) and frailty groups (OR = 3.52, 95% CI: 1.09–12.26) were found to be significantly more likely to experience POD postoperatively compared with the nonfrail group. Being frail (RR = 1.42, 95% CI: 1.01–2.00) was significantly associated with a higher likelihood of increased LOS after surgery compared with nonfrail participants.

4.3 | Predictive ability of the REFS-Thai compared with standard assessments

Comparisons of AUC values of the ROC curve were analysed for predictive ability of ASA class, EMC score and REFS-Thai for the outcomes (Table 3). Age, gender, type of surgery and comorbidity were treated as covariates and adjusted for in the model.

Considering a single assessment (Figure 1), the AUC values for predicting the model of postoperative complications or adverse events according to EMC score, ASA (class III and IV) and REFS-Thai (three categories) were 0.79 (95% CI: 0.73–0.87), 0.80 (95% CI: 0.73–0.87) and 0.81 (95% CI: 0.74–0.88), respectively. The REFS-Thai exhibited good performance for predicting POD (AUC =0.81; 95% CI: 0.72–0.90) on par with the standard assessments. For LOS, EMC scores showed the best predictive ability (MSE bias-corrected = 51.93). For discharge disposition, all three tools demonstrated poor predictive power (AUC = 0.6-0.7). For clinical screening (Appendix: Supplement 3), the REFS-Thai demonstrated good performance for identifying POD (sensitivity = 75%; specificity = 90%; PPV = 24%; NPV = 99%) and postoperative complications (sensitivity = 71%; specificity = 83%; PPV = 47%; NPV = 93%). For discharge disposition, all three tools demonstrated poor clinical screening performance; there were not enough observational data to justify the precision of screening (Appendix: Supplement 3).

Combining frailty assessment with other preoperative assessment tools for predicting postoperative complications revealed that combining standard assessment measures with REFS-Thai exhibited better predictive performance compared with the REFS-Thai alone: EMC scoring combined with the REFS-Thai (AUC = 0.82, 95% CI: 0.75–0.88), ASA class combined with REFS-Thai (AUC = 0.81, 95% CI: 0.75–0.88) and EMC scoring combined with the ASA class (AUC = 0.80, 95% CI: 0.74–0.87). For predicting POD occurrence, the REFS-Thai showed a good ability to predict (AUC = 0.81, 95% CI: 0.72–0.90). Most instruments demonstrated poor ability to predict discharge disposition, although the AUC value of the combination of EMC and REFS-Thai was 0.68 (95% CI: 0.55–0.80) which was higher than the other combinations tested. The combination of EMC scoring with REFS-Thai (MSE bias-corrected = 53.60) showed slightly better predictive ability for prolonged LOS than the other combinations (Table 3). Combining the REFS-Thai with standard assessment demonstrated a slight improvement in screening for postoperative complications (sensitivity = 71%; specificity = 83%; PPV = 47%; NPV = 93% 9, combined with EMC scoring) and POD (sensitivity = 71%; specificity = 83%; PPV = 47%; NPV = 93%, combined with either EMC scoring or ASA). However, there were not enough observational data to justify a combined screening approach for discharge disposition (Appendix: Supplement 3).

5 | DISCUSSION

To the best of our knowledge, the present study is the first to apply a Thai version of a frailty screening instrument to estimate frailty prevalence in hospitalised older adults undergoing orthopaedic surgery. Study participants who were classified as frail in an orthopaedic acute setting tended to be older, female and with moderate-to-severe comorbid health conditions. The current findings highlight the importance of preoperative frailty assessment in this population. The REFS-Thai exhibited good performance in predicting postoperative complications and POD. The current study also highlighted that applying the REFS-Thai exhibited good performance in predicting postoperative complications and POD, but fair performance of discharge disposition when used alone or together as a combined evaluation with standard preoperative assessments (ASA class and EMC).

The findings of the current study were in accord with previous reports regarding the characteristics of frailty and the impact of frailty on health in hospitalised older adults. Frail hospitalised older adults are at increased risk of developing postoperative complications, prolonged LOS, adverse events, and inpatient mortality (Cooper et al., 2016; Gleason et al., 2017; Ondeck, et al., 2018; Shin et al., 2016; Walters et al., 2016). The current findings are consistent with other studies in which frailty was found in older adults with MSK conditions, such as osteoporotic fracture, hip or knee OA, and degenerative spine diseases (McGuigan et al., 2017; Zlobina et al., 2015). Although previous studies reported that the prevalence of frailty in MSK conditions was relatively low (approximately 10%) (Choi et al., 2015; Nguyen et al., 2015), the current findings revealed a higher prevalence of frailty (n = 46, 23%) in Thai hospitalised older adults with MSK conditions. Moreover, our findings were in accord with previous research concerning the association between frailty and being female (de Labra et al., 2018; Lee et al., 2018).

The present results support previous findings in orthopaedic populations regarding the association among preoperative frailty, adverse events or postoperative complications, inability to discharge to the home, POD, and increased LOS (Cooper et al., 2016; Gleason et al., 2017; Ondeck, et al., 2018; Shin et al., 2016; Walters et al., 2016). The current results revealed that frail patients who had hip surgery were at risk of developing postoperative complications with increased LOS, consistent with other frailty studies in total hip replacement (Bellamy et al., 2017; Ondeck, et al., 2018). Complications from surgery in the current study, including minor to life-threatening complications, were found in 26.5% of cases, similar to the proportion reported in previous studies (Flexman et al., 2016; Kua et al., 2016; Ondeck, et al., 2018; Vu et al., 2017). Also, the adverse event in-hospital mortality was reported in frail older adults who underwent total hip replacement, which was a rare occurrence in the present report. These findings of the present study were in accordance with previously reported evidence that frail patients who underwent surgery were more likely to develop a higher risk of adverse outcomes (Buigues et al., 2015; Lin et al., 2016; Shin et al., 2016).

The findings from the current study share similarities with other studies reporting an increased risk of having POD with orthopaedic surgery (Birkelbach et al., 2019; Pollard et al., 2015). The occurrence of POD in this study (12.5%) was episodic and unpredictable. POD occurred most frequently at 24 hours after surgery (52%). Interestingly, 48% of POD occurred on the day of discharge,

TABLE 1 Preoperative and postoperative characteristics of the sample (n = 200).

Characteristics	n (%)	Mean (SD)	Range
Age, years		72 (7.5)	6–94
Mini-Cog score		4 (0.9)	3–5
Time to complete REFS-Thai (minute)		5 (1.7)	2–11
EMC score		0 (5.12)	9–19
4AT score at admission		0 (1.07)	0–6
4AT score at 24-hours after surgery		1 (1.49)	0–12
4AT score at discharge		0 (1.38)	0–12
BMI (kg/m^2)		25.90 (4.12)	17.13–39.52
Pain score at preoperational		3 (2.95)	0–10
LOS (days)		7 (7.26)	3–84
Gender, n (%) of Female	156 (78)		
BMI classification (kg/m^2)			
Underweight	6 (3)		
Normal	39 (9)		
Overweight	44 (22)		
Pre-obese	78 (39)		
Obese	33 (16.5)		
Frailty category			
Nonfrail	114 (57)		
Apparent frailty	40 (20)		
Mild frailty	19 (95)		
Moderate frailty	19 (95)		
Severe frailty	8 (4)		
Religion			
Buddhism	195 (975)		
Christian	3 (15)		
Islamic	2 (1)		
Educational level			
Did not attend school	16 (8)		
Primary school	103 (51.5)		
Middle and/or high school	26 (13)		
Diploma degree	11 (55)		
Bachelor's degree	35 (175)		
Master's degree or higher	9 (45)		
Income			
Income, n (%) with insufficient income	20 (10)		
Occupation			
Not working/ Retired	160 (80)		
Merchant	19 (9.5)		
Agriculture	8 (4)		
Employed	7 (35)		
Government/State Enterprise officers	3 (15)		
Other			

(Continues)

TABLE 1 (Continued)

Characteristics	n (%)	Mean (SD)	Range
Medical payment			
Government/State Enterprise	122 (61)		
Universal Coverage Scheme (UC 30 Baht)	54 (27)		
Personal payment	21 (105)		
Social Security payment	3 (15)		
Comorbidity			
Comorbidity, n (%) report comorbidity(s)	180 (90)		
ASA* classification			
Class I	3 (15)		
Class II	70 (35)		
Class III	119 (595)		
Class IV	8 (4)		
Type of surgery			
Knee	116 (58)		
Spine	48 (24)		
Hip	36 (18)		
Complications/adverse events, n (%)	53 (265)		
Postoperative delirium (POD), n (%)	25 (125)		
24 hour-postoperative	13 (52)		
Discharge day	12 (48)		
Discharge disposition, n (%) of inability to discharge home	22 (11%)		

Abbreviations: ASA, American Society of Anesthesiologists (ASA) physical status classification; EMC scoring, Elixhauser comorbidity measure; LOS, length of hospital stay; REFS-Thai, the reported edmonton frail scale-Thai version; 4AT, the thai version of the 4 "A"s Test.

although there was no documentation of active delirium in the medical records. Delirium is difficult to identify and diagnose, particularly if it is hypoactive or mixed delirium (Pollard et al., 2015). Undetected or late diagnosis of POD during hospital admission can result in increased dependency, poor functional recovery and decreased quality of life following discharge (Pollard et al., 2015). POD during hospital admission increases the risk of 1-year mortality (Hamilton et al., 2017; Ruggiero et al., 2017). Furthermore, older adults who experience POD without dementia may be at higher risk of later development of preclinical dementia or Alzheimer's disease (Davis et al., 2012; Idland et al., 2017). We found that both apparent frailty and frail patients developed POD. Therefore, effective detection of POD and prompt treatment is vital for preventing poor health outcomes (Pollard et al., 2015). The current findings underscore the significance of early detection of POD in orthopaedic patients, including monitoring from admission to postdischarge, and until POD resolves.

Although the present study revealed no association between preoperative frailty and discharge disposition, this finding may have been due to the small percentage (10%) of participants who were transferred to other care facilities. Furthermore, the sample consisted of participants scheduled for elective surgery, which may have led to selection bias, contributing to the lack of an association with discharge disposition. However, the current results were similar to those of a previous report that preoperative frailty in orthopaedic patients can result in an inability to discharge to the home and an ongoing need for personal care assistance (Cooper et al., 2016; Gleason et al., 2017; Ondeck, et al., 2018; Shin et al., 2016; Walters et al., 2016). Importantly, orthopaedic patients undergoing hip and spinal surgery require time and continuing care to regain optimal physical function. The consequences of postsurgery physical or functional limitations may increase frailty severity, requiring long-term care (McGuigan et al., 2017; Zlobina et al., 2015). Because MSK conditions are chronic, additional research on transitional or continuing care after surgical interventions is needed.

The current finding that preoperative frailty was significantly associated with greater LOS is consistent with previous studies in orthopaedic patients (Cooper et al., 2016; Gleason et al., 2017; Wang et al., 2018). In addition, LOS might have been increased because of other factors, such as the type of surgery and/or postoperative adverse events or intraoperative incidence. Hip, knee and spine surgery are complicated surgeries that often result in adverse events or postoperative complications, and extended LOS in frail patients is well documented (Ondeck, et al., 2018; Wang et al., 2018). Intraoperative complications such as a dural tear, nerve damage, bleeding, anaesthesia-related events, and cardiopulmonary events can increase LOS. The present findings identified various postoperative complications and adverse events from minor to life-threatening

TABLE 2 The estimated odds ratios (ORs) and relative risks (RRs) from logistic regression and Poisson regression of preoperative frailty levels using the REFS-Thai measure on postoperative outcomes in 200 orthopaedic patients.

Outcomes/frailty	Univariate (95% CI)	*p* value	Adjusted* (95% CI)	*p* value
Postoperative complication				
Nonfrail	1 (reference)		(reference)	
Apparent frailty	1.39 (0.56–3.25)	.462	0.82 (0.30–2.10)	.697
Frailty	5.01 (2.40–10.72)	<.001**	2.38 (1.00–5.64)	.049*
Postoperative delirium (POD)	OR (95% CI)		OR (95% CI)	
Nonfrail	1 (reference)		(reference)	
Apparent frailty	5.20 (1.69–17.34)	.004*	3.75 (1.14–13.15)	.029*
Frailty	7.21 (2.57–22.84)	<.001**	3.52 (1.09–12.26)	.034*
Discharge disposition	OR (95% CI)		OR (95% CI)	
Nonfrail	1 (reference)		(reference)	
Apparent frailty	0.64 (0.16–2.00)	.471	0.60 (0.14–1.96)	.420
Frailty	1.11 (0.38–2.91)	.834	0.85 (0.25–2.55)	.779
Length of stay (LOS)	RR** (95% CI)		RR** (95% CI)	
Nonfrail	1 (reference)		(reference)	
Apparent frailty	1.63 (0.99–2.66)	.051	1.55 (0.90–2.53)	.113
Frailty	1.63 (1.23–2.15)	<.001**	1.42 (1.01–2.00)	.043*

For data analysis, the 5 classifications of frailty were rearranged into three [nonfrail, apparent frailty and frailty (mild, moderate and severe frailty)].

Abbreviation: RR, relative risk of robust Poisson regression.

*The multiple Firth logistic regression and Poisson regression tests were applied with adjusted variables: age, gender, type of surgery, comorbidity.

**Highlights the level of significance < .001

TABLE 3 Estimates of the diagnostic ability of the preoperative REFS-Thai and other standard assessments to predict postoperative health events among 200 orthopaedic patients.

*Predictors	Postoperative complications (AUC) (95%CI)	POD (AUC) (95%CI)	Discharge disposition (AUC) (95%CI)	LOS (MSE) (bias-corrected)
ASA class 3 and over	0.80 (0.73–0.87)	0.77 (0.67–0.87)	0.62 (0.50–0.75)	52.39 (52.04)
EMC scoring	0.79 (0.73–0.87)	0.77 (0.68–0.87)	0.67 (0.54–0.79)	52.25 (51.93)
REFS-Thai	0.81 (0.74–0.88)	0.81 (0.72–0.90)	0.65 (0.53–0.77)	54.58 (53.93)
ASA class 3 and over +REFS-Thai	0.81 (0.75–0.88)	0.80 (0.71–0.89)	0.64 (0.53–0.76)	54.35 (53.76)
EMC scoring +REFS-Thai	0.82 (0.75–0.88)	0.81 (0.72–0.90)	0.68 (0.55–0.80)	54.16 (53.60)
ASA class 3 and over +EMC scoring	0.80 (0.74-0.87)	0.78 (0.68-0.87)	0.66 (0.54-0.78)	53.17 (52.74)

Abbreviations: ASA, American Society of Anesthesiologists (ASA) physical status classification; AUC, area under the curve; CI, confidence interval; EMC scoring, Elixhauser Comorbidity Measure; LOS, length of stay; MSE, standard mean squared error; POD, postoperative delirium; REFS-Thai, the Reported Edmonton Frail Scale-Thai version.

*Adjusted for:age > 60 years, gender, comorbidity and type of surgery; Poisson regression was analysed for LOS, while the Firth logistic regression was used for the others.

complications, such as respiratory failure requiring intubation, UTI, DVT/PE, stroke, unplanned ICU admission, and acute cardiac arrest. These findings are also in accord with previous studies regarding adverse events and common postoperative complications in orthopaedic patients (Ali et al., 2016; Kua et al., 2016; Ondeck, et al., 2018). The current results also support previous evidence indicating that frail individuals can experience unpleasant outcomes resulting from a trigger stressor like orthopaedic surgery (Fried et al., 2001).

Because of the lack of standard assessment of frailty, many instruments have been developed to measure frailty, including the

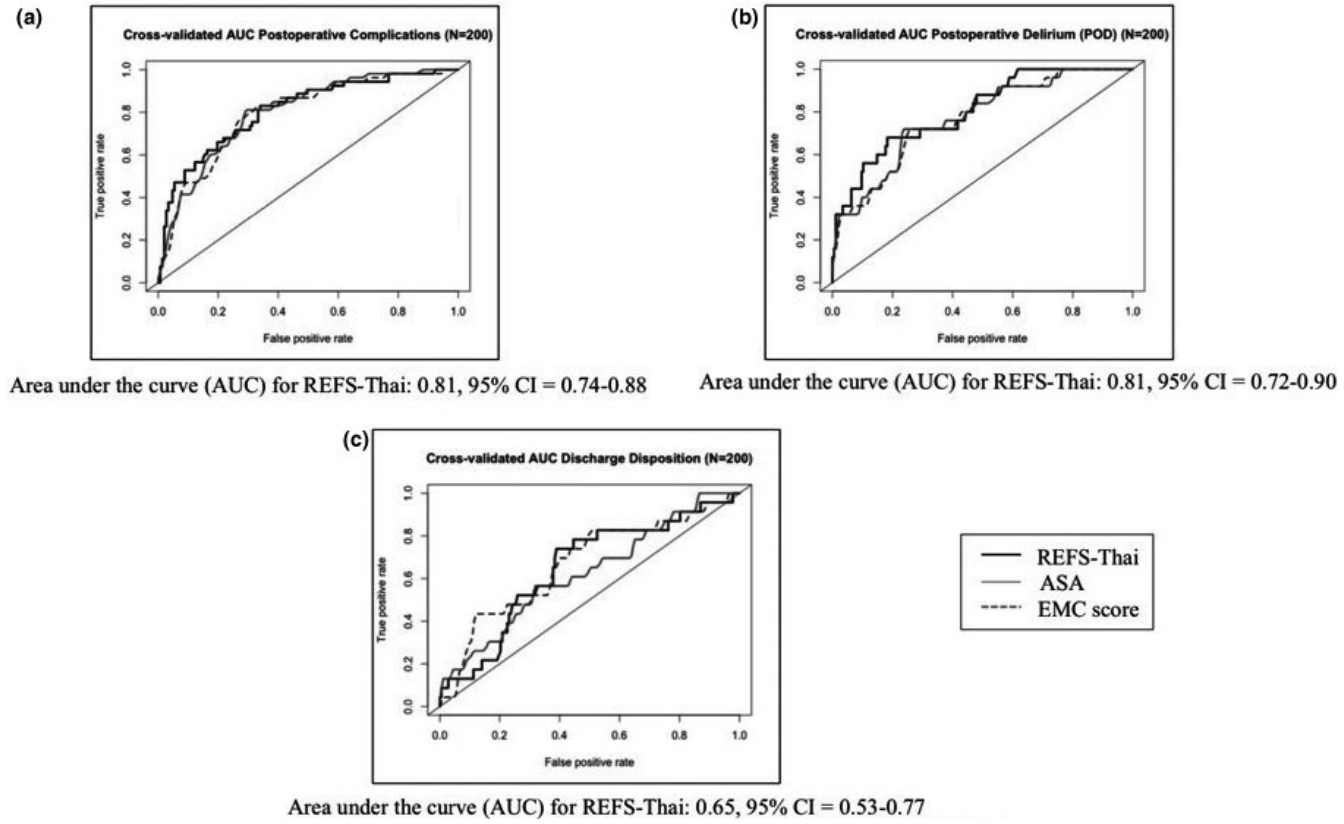

FIGURE 1 Prediction of outcomes by preoperative REFS-Thai scores and standard instruments. ROC: receiver operating characteristics

REFS (Dent et al., 2016; Kua et al., 2016). The current study demonstrated that the REFS-Thai is a valid and easily administered (< 5 minutes) instrument for detecting frailty and predicting adverse outcomes in older Thai orthopaedic patients. Although the standard preoperative assessments (ASA and EMC scoring) demonstrated good prediction of adverse outcomes, the REFS-Thai performed better than these standard assessments for POD. Moreover, the REFS-Thai exhibited improved predictive ability for other postoperative outcomes when combined with ASA and EMC scoring. The current findings reinforce the usefulness of the REFS-Thai for detecting frailty compared with standard assessments in the Thai context. Integrating the REFS-Thai into preoperative assessment may be beneficial for early detection of frailty, and the provision of better care, particularly for identifying individuals at risk of developing delirium. As a result of the complexity of frailty, the identification and management of frailty should include evaluation of a range of health dimensions (Dent et al., 2016; Theou et al., 2018). Moreover, routine preoperative identification of frailty could be useful for improving surgical planning, enhancing patient-centred discharge planning, and strengthening transition and continuity of care in this population.

5.1 | Limitations

This prospective cohort study provides additional information, and may be the first published study to apply preoperative frailty assessment in older adults undergoing orthopaedic surgery in Thailand. However, the current study involved several limitations that should be considered. The sample was recruited from one university hospital with the majority of participants residing in urban areas. As such, the findings may have limited generalisability. In addition, several variables that might be relevant to the evaluation of frailty were not included (e.g., muscle and fat mass, grip strength, Interleukin-6, C-reactive protein and 25-hydroxyvitamin-D). The potential impact of these variables warrants further study. Investigating frailty in other orthopaedic settings, expanding frailty evaluation and validation in rural hospitals, including a larger number of hip and spine surgery cases, including both emergency and elective cases, and re-evaluating frailty after discharge are important next steps for expanding current knowledge. Furthermore, extending research on cross-cultural validation could provide a better understanding of frailty in other countries. Ultimately, the current findings will support the development of proactive interventions for preoperative or long-term care.

6 | CONCLUSIONS

The current findings provide evidence about frailty in Thai hospitalised older adults undergoing orthopaedic surgery. Integrating the REFS-Thai into preoperative routines to identify frailty earlier will be useful for strengthening frailty screening, predicting

unpleasant postoperative outcomes, and enhancing care quality in this population.

7 | RELEVANCE TO CLINICAL PRACTICE

The current results revealed that the impact of frailty on adverse surgical outcomes is of paramount concern, and that practical preoperative frailty screening is critical, even in settings with limited resources. The findings of the present study provided substantial evidence for the importance of nurses and clinical healthcare professionals applying valid frailty screening, such as the REFS-Thai, either as a single tool or combined with standard preoperative assessment. The REFS-Thai provides a pragmatic method for risk modification, improving surgical decision-making, patient-centred discharge planning, and quality of care.

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CONFLICT OF INTEREST

All authors have no conflicts of interest to disclose.

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REFERENCES

Aitken, S. J., Blyth, F. M., & Naganathan, V. (2017). Incidence, prognostic factors and impact of postoperative delirium after major vascular surgery: A meta-analysis and systematic review. *Vascular Medicine*, *22*(5), 387–397. https://doi.org/10.1177/1358863x17721639

Ali, R., Schwalb, J. M., Nerenz, D. R., Antoine, H. J., & Rubinfeld, I. (2016). Use of the modified frailty index to predict 30-day morbidity and mortality from spine surgery. *Journal of Neurosurgery Spine*, *25*(4), 537–541. https://doi.org/10.3171/2015.10.spine14582

Beaudart, C., Reginster, J. Y., Petermans, J., Gillain, S., Quabron, A., Locquet, M., & Bruyère, O. (2015). Clinical components linked to sarcopenia: The sarcophage study. *Osteoporosis International*, *26*(1), S144.

Bellamy, J. L., Runner, R. P., Vu, C. C. L., Schenker, M. L., Bradbury, T. L., & Roberson, J. R. (2017). Modified frailty index is an effective risk assessment tool in primary total hip arthroplasty. *Journal of Arthroplasty*, *32*(10), 2963–2968. https://doi.org/10.1016/j.arth.2017.04.056

Birkelbach, O., Mörgeli, R., Spies, C., Olbert, M., Weiss, B., Brauner, M., Neuner, B., Francis, R. C. E., Treskatsch, S., & Balzer, F. (2019). Routine frailty assessment predicts postoperative complications in elderly patients across surgical disciplines: A retrospective observational study. *BMC Anesthesiology*, *19*(1), 204. https://doi.org/10.1186/s12871-019-0880-x

Briggs, A. M., Cross, M. J., Hoy, D. G., Sanchez-Riera, L., Blyth, F. M., Woolf, A. D., & March, L. (2016). Musculoskeletal health conditions represent a global threat to healthy aging: A report for the 2015 World Health Organization world report on ageing and health. *Gerontologist*, *56*(Suppl 2), S243–S255. https://doi.org/10.1093/geront/gnw002

Briggs, A. M., & Dreinhofer, K. E. (2017). Rehabilitation 2030: A call to action relevant to improving musculoskeletal health care globally. *Journal of Orthopaedic & Sports Physical Therapy*, *47*(5), 297–300. https://doi.org/10.2519/jospt.2017.0105

Buigues, C., Juarros-Folgado, P., Fernandez-Garrido, J., Navarro-Martinez, R., & Cauli, O. (2015). Frailty syndrome and pre-operative risk evaluation: A systematic review. *Archives of Gerontology and Geriatrics*, *61*(3), 309–321. https://doi.org/10.1016/j.archger.2015.08.002

Cesari, M., & Vellas, B. (2015). Frailty in clinical practice. *Nestle Nutrition Institute Workshop Series*, *83*, 93–98. https://doi.org/10.1159/000382091

Choi, J., Ahn, A., Kim, S., & Won, C. W. (2015). Global prevalence of physical frailty by Fried's criteria in community-dwelling elderly with national population-based surveys. *Journal of the American Medical Directors Association*, *16*(7), 548–550. https://doi.org/10.1016/j.jamda.2015.02.004

Cooper, Z., Rogers, S. O., Ngo, L., Guess, J., Schmitt, E., Jones, R. N., Ayres, D. K., Walston, J. D., Gill, T. M., Gleason, L. J., Inouye, S. K., & Marcantonio, E. R. (2016). Comparison of frailty measures as predictors of outcomes after orthopedic surgery. *Journal of the American Geriatrics Society*, *64*(12), 2464–2471. https://doi.org/10.1111/jgs.14387

Cross, M., Smith, E., Hoy, D., Nolte, S., Ackerman, I., Fransen, M., Bridgett, L., Williams, S., Guillemin, F., Hill, C. L., Laslett, L. L., Jones, G., Cicuttini, F., Osborne, R., Vos, T., Buchbinder, R., Woolf, A., & March, L. (2014). The global burden of hip and knee osteoarthritis: Estimates from the global burden of disease 2010 study. *Annals of the Rheumatic Diseases*, *73*(7), 1323–1330. https://doi.org/10.1136/annrheumdis-2013-204763

Cunha, A. I. L., Veronese, N., de Melo Borges, S., & Ricci, N. A. (2019). Frailty as a predictor of adverse outcomes in hospitalized older adults: A systematic review and meta-analysis. *Ageing Research Reviews*, *56*, 100960. https://doi.org/10.1016/j.arr.2019.100960

Davis, D. H. J., Muniz Terrera, G., Keage, H., Rahkonen, T., Oinas, M., Matthews, F. E., Cunningham, C., Polvikoski, T., Sulkava, R., MacLullich, A. M. J., & Brayne, C. (2012). Delirium is a strong risk factor for dementia in the oldest-old: A population-based cohort study. *Brain: A: Journal of Neurology*, *135*(Pt 9), 2809–2816. https://doi.org/10.1093/brain/aws190

de Labra, C., Maseda, A., Lorenzo-Lopez, L., Lopez-Lopez, R., Bujan, A., Rodriguez-Villamil, J. L., & Millan-Calenti, J. C. (2018). Social factors and quality of life aspects on frailty syndrome in community-dwelling older adults: The VERISAUDE study. *BMC Geriatrics*, *18*(1), 66. https://doi.org/10.1186/s12877-018-0757-8

Dent, E., Kowal, P., & Hoogendijk, E. O. (2016). Frailty measurement in research and clinical practice: A review. *European Journal of Internal Medicine*, *31*, 3–10. https://doi.org/10.1016/j.ejim.2016.03.007

Flexman, A. M., Charest-Morin, R., Stobart, L., Street, J., & Ryerson, C. J. (2016). Frailty and postoperative outcomes in patients undergoing surgery for degenerative spine disease. *Spine Journal*, *16*(11), 1315–1323. https://doi.org/10.1016/j.spinee.2016.06.017

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W. J., Burke, G., & McBurnie, M. A. (2001). Frailty in older adults: Evidence for a phenotype. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *56*(3), M146–M156.

Gleason, L. J., Benton, E. A., Alvarez-Nebreda, M. L., Weaver, M. J., Harris, M. B., & Javedan, H. (2017). FRAIL questionnaire screening

tool and short-term outcomes in geriatric fracture patients. *Journal of the American Medical Directors Association*, *18*(12), 1082–1086. https://doi.org/10.1016/j.jamda.2017.07.005

Hamilton, G. M., Wheeler, K., Di Michele, J., Lalu, M. M., & McIsaac, D. I. (2017). A systematic review and meta-analysis examining the impact of incident postoperative delirium on mortality. *Anesthesiology*, *127*(1), 78–88. https://doi.org/10.1097/ALN.0000000000001660

Healy, M. A., Mullard, A. J., Campbell, D. A. Jr, & Dimick, J. B. (2016). Hospital and payer costs associated with surgical complications. *JAMA Surgery*, *151*(9), 823–830. https://doi.org/10.1001/jamasurg.2016.0773

Idland, A.-V., Wyller, T. B., Stoen, R., Eri, L. M., Frihagen, F., Raeder, J., & Watne, L. O. (2017). Preclinical amyloid-beta and axonal degeneration pathology in delirium. *Journal of Alzheimer's Disease*, *55*(1), 371–379. https://doi.org/10.3233/JAD-160461

Kua, J., Ramason, R., Rajamoney, G., & Chong, M. S. (2016). Which frailty measure is a good predictor of early post-operative complications in elderly hip fracture patients? *Archives of Orthopaedic and Trauma Surgery*, *136*(5), 639–647. https://doi.org/10.1007/s00402-016-2435-7

Kuladee, S., & Prachason, T. (2016). Development and validation of the Thai version of the 4 "A"s Test for delirium screening in hospitalized elderly patients with acute medical illnesses. *Neuropsychiatric Disease and Treatment*, *12*, 437–443. https://doi.org/10.2147/ndt.s97228

Lee, D. R., Santo, E. C., Lo, J. C., Ritterman Weintraub, M. L., Patton, M., & Gordon, N. P. (2018). Understanding functional and social risk characteristics of frail older adults: A cross-sectional survey study. *BMC Family Practice*, *19*(1), 170. https://doi.org/10.1186/s12875-018-0851-1

Lin, H. S., Peel, N. M., & Hubbard, R. E. (2016). Baseline vulnerability and inpatient frailty status in relation to adverse outcomes in a surgical cohort. *Journal of Frailty & Aging*, *5*(3), 180–182. https://doi.org/10.14283/jfa.2016.101.

McGuigan, F. E., Bartosch, P., & Akesson, K. E. (2017). Musculoskeletal health and frailty. *Best Practice & Research Clinical Rheumatology*, *31*(2), 145–159. https://doi.org/10.1016/j.berh.2017.11.002

Mehta, H. B., Dimou, F., Adhikari, D., Tamirisa, N. P., Sieloff, E., Williams, T. P., & Riall, T. S. (2016). Comparison of comorbidity scores in predicting surgical outcomes. *Medical Care*, *54*(2), 180–187. https://doi.org/10.1097/MLR.0000000000000465

Menendez, M. E., Neuhaus, V., van Dijk, C. N., & Ring, D. (2014). The Elixhauser comorbidity method outperforms the Charlson index in predicting inpatient death after orthopaedic surgery. *Clinical Orthopaedics and Related Research*, *472*(9), 2878–2886. https://doi.org/10.1007/s11999-014-3686-7

Nguyen, T. N., Cumming, R. G., & Hilmer, S. N. (2015). A review of frailty in developing countries. *Journal of Nutrition, Health & Aging*, *19*(9), 941–946. https://doi.org/10.1007/s12603-015-0503-2

Ondeck, N. T., Bohl, D. D., Bovonratwet, P., McLynn, R. P., Cui, J. J., & Grauer, J. N. (2018). Discriminative ability of Elixhauser's comorbidity measure is superior to other comorbidity scores for inpatient adverse outcomes after total hip arthroplasty. *Journal of Arthroplasty*, *33*(1), 250–257. https://doi.org/10.1016/j.arth.2017.08.032

Ondeck, N. T., Bovonratwet, P., Ibe, I. K., Bohl, D. D., McLynn, R. P., Cui, J. J., Baumgaertner, M. R., & Grauer, J. N. (2018). Discriminative ability for adverse outcomes after surgical management of hip fractures: A comparison of the Charlson comorbidity index, Elixhauser comorbidity measure, and modified frailty index. *Journal of Orthopaedic Trauma*, *32*(5), 231–237. https://doi.org/10.1097/bot.0000000000001140

Pollard, C., Fitzgerald, M., & Ford, K. (2015). Delirium: The lived experience of older people who are delirious post-orthopaedic surgery. *International Journal of Mental Health Nursing*, *24*(3), 213–221. https://doi.org/10.1111/inm.12132

Roopsawang, I., Thompson, H., Zaslavsky, O., & Belza, B. (2020). The Reported Edmonton Frail Scale-Thai version: Development and validation of a culturally-sensitive instrument. *Nursing & Health Sciences*, *22*(3), 685–693. https://doi.org/10.1111/nhs.12713

Ruggiero, C., Bonamassa, L., Pelini, L., Prioletta, I., Cianferotti, L., Metozzi, A., Benvenuti, E., Brandi, G., Guazzini, A., Santoro, G. C., Mecocci, P., Black, D., & Brandi, M. L. (2017). Early post-surgical cognitive dysfunction is a risk factor for mortality among hip fracture hospitalized older persons. *Osteoporosis International*, *28*(2), 667–675. https://doi.org/10.1007/s00198-016-3784-3

Sankar, A., Johnson, S. R., Beattie, W. S., Tait, G., & Wijeysundera, D. N. (2014). Reliability of the American society of anesthesiologists physical status scale in clinical practice. *British Journal of Anaesthesia*, *113*(3), 424–432. https://doi.org/10.1093/bja/aeu100

Shin, J. I., Keswani, A., Lovy, A. J., & Moucha, C. S. (2016). Simplified frailty index as a predictor of adverse outcomes in total hip and knee arthroplasty. *Journal of Arthroplasty*, *31*(11), 2389–2394. https://doi.org/10.1016/j.arth.2016.04.020

Sieber, C. C. (2017). Frailty: From concept to clinical practice. *Experimental Gerontology*, *87*(B), 160–167. https://doi.org/10.1016/j.exger.2016.05.004

Theou, O., Squires, E., Mallery, K., Lee, J. S., Fay, S., Goldstein, J., Armstrong, J. J., & Rockwood, K. (2018). What do we know about frailty in the acute care setting? A Scoping Review. *BMC Geriatrics*, *18*(1), 139. https://doi.org/10.1186/s12877-018-0823-2

Trongsakul, S., Lambert, R., Clark, A., Wongpakaran, N., & Cross, J. (2015). Development of the Thai version of Mini-Cog, a brief cognitive screening test. *Geriatrics & Gerontology International*, *15*(5), 594–600. https://doi.org/10.1111/ggi.12318

van Walraven, C., Austin, P. C., Jennings, A., Quan, H., & Forster, A. J. (2009). A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. *Medical Care*, *47*(6), 626–633. https://doi.org/10.1097/MLR.0b013e31819432e5

Vu, H. T. T., Nguyen, T. X., Nguyen, T. N., Nguyen, A. T., Cumming, R., Hilmer, S., & Pham, T. (2017). Prevalence of frailty and its associated factors in older hospitalised patients in Vietnam. *BMC Geriatrics*, *17*(1), 216. https://doi.org/10.1186/s12877-017-0609-y

Walters, S., Chan, S., Goh, L., Ong, T., & Sahota, O. (2016). The prevalence of frailty in patients admitted to hospital with vertebral fragility fractures. *Current Rheumatology Reviews*, *12*(3), 244–247.

Wang, H. T., Fafard, J., Ahern, S., Vendittoli, P.-A., & Hebert, P. (2018). Frailty as a predictor of hospital length of stay after elective total joint replacements in elderly patients. *BMC Musculoskeletal Disorders*, *19*(1), 14. https://doi.org/10.1186/s12891-018-1935-8

Zlobina, I. A., Krivtsunov, A. N., Bogat, S. V., & Prashchayeu, K. I. (2015). Musculoskeletal system as a target organ of a frailty processes. *Advances in Gerontology*, *28*(4), 725–--728.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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