BJA

British Journal of Anaesthesia, 125 (4): 614–621 (2020)

doi: 10.1016/j.bja.2020.06.040
Advance Access Publication Date: 21 July 2020
Quality and Patient Safety

Validation and clinical utility of the Korean version of the Quality of Recovery-15 with enhanced recovery after surgery: a prospective observational cohort study

Susie Yoon[1,2], Hyundeok Joo[3], Yoo Min Oh[1], Jihye Lee[4], Jae-Hyon Bahk[1,2] and Ho-Jin Lee[1,2,*]

[1]Department of Anaesthesiology and Pain Medicine, Seoul National University Hospital, Seoul, South Korea, [2]Department of Anaesthesiology and Pain Medicine, Seoul National University College of Medicine, Seoul, South Korea, [3]Seoul National University College of Medicine, Seoul, South Korea and [4]Occupational Safety and Health Research Institute, Incheon, South Korea

*Corresponding author. E-mail: zenerdiode03@gmail.com

Abstract

Background: The 15-item Quality of Recovery (QoR-15) scale is a validated patient-reported outcome questionnaire that measures the quality of postoperative recovery. This study aimed to validate a translated Korean version of QoR-15 (QoR-15K) in a broad range of surgical patients.
Methods: After Korean translation of the original English version of the QoR-15, we performed psychometric validation of the QoR-15K to evaluate the quality of recovery after surgery. The validity, reliability, responsiveness, and clinical feasibility of the QoR-15K were evaluated. A subgroup analysis in patients with video-assisted lung resection was performed.
Results: Among 193 patients, 188 (97.4%) completed the QoR-15K after surgery. We found good convergent validity between the postoperative QoR-15K and the global QoR visual analogue scale (ρ=0.61, P<0.001). The negative correlation between the QoR-15K score and the extent of surgery (ρ=−0.33, P<0.001), the duration of surgery (ρ=−0.33, P<0.001), and the severity of postoperative pain (ρ=−0.40, P<0.001) supported construct validity. The postoperative QoR-15K showed good internal consistency (Cronbach α=0.90), split-half reliability (0.81), and test–retest reliability (0.95; 95% confidence interval [CI], 0.94–0.96). The QoR-15K score decreased from 140 (preoperative, inter-quartile range [IQR] 128–146) to 100 (postoperative day 1, IQR 75–122), median difference −36.5 (95% CI, −41 to −32.5; P<0.0001). The QoR-15K indicated excellent responsiveness with Cliff's effect size −0.78 (95% CI, −0.84 to −0.71). Subgroup analysis yielded similar results.
Conclusions: The QoR-15K is valid and has excellent reliability, a high degree of responsiveness, and clinical feasibility as a metric of quality of recovery in Korean surgical population.
Clinical trial registration: NCT04169087.

Keywords: enhanced recovery after surgery; patient-reported outcome measures; patient outcome assessment; perioperative medicine; quality of recovery

Editor's key points

- Patient-centred outcome measures are essential to evaluate high-quality perioperative care.
- The 15-item quality of recovery (QoR-15) scale has been extensively validated, but cultural and linguistic specificity demand further evaluation.
- This study offers a high level of support for the validity, reliability, and clinical utility of a Korean translation of the QoR-15.

Received: 6 May 2020; **Accepted:** 22 June 2020

Most studies evaluating postoperative recovery have focused on audit measures such as the physiological parameters including pain, nausea/vomiting, recovery of bowel function, length of hospital stay, and postoperative morbidity and mortality.[1] However, the introduction of minimally invasive surgery and the advance of perioperative management have improved these outcomes, making it difficult to identify meaningful differences in outcome of new treatments using these measures.[2] Furthermore, postoperative recovery is a complex and multidimensional process affected by physical, psychological, and social aspects.[2,3] Therefore, several multidimensional parameters have been developed to measure postoperative recovery.[4]

One of them, the 15-item Quality of Recovery-15 (QoR-15) scale, is a widely used self-rated questionnaire for early postoperative quality of recovery.[5] It is a shortened version of the previous 40-item questionnaire (QoR-40)[6] and composed of 15 items of five dimensions: physical well-being, physical independence, emotional state, psychological support, and pain. Higher scores indicate better quality of recovery. Its simplicity compared with the QoR-40 could increase the feasibility in the immediate postoperative period, while retaining its validity as an assessment tool for postoperative recovery.[5] It has been successfully translated and validated in several languages.[7–10] The European Society of Anaesthesiology and the American Society for Enhanced Recovery and Perioperative Quality Initiative recommended the QoR-15 for evaluating perioperative clinical outcome.[3,11]

However, the Korean version of QoR-15 (QoR-15K) has not been previously validated. We hypothesised that the QoR-15K would have similar psychometric characteristics in assessing the quality of postoperative recovery as its original version.[5] We also investigated the QoR-15K in patients with video-assisted thoracic surgery (VATS) lung resection, as a preliminary study of the enhanced recovery after surgery (ERAS).

Methods

This prospective observational study was approved by the Institutional Review Board of Seoul National University Hospital, South Korea (No. 1911-038-1077), and registered with ClinicalTrials.gov (NCT04169087, November 19, 2019). All participants provided written informed consent before study entry, and the study was conducted in accordance with the Declaration of Helsinki. All methods were carried out following the Strengthening the Reporting of Observational Studies in Epidemiology guideline.[12]

We planned to recruit 200 patients who were admitted for elective surgery under general anaesthesia in our division. The sample size of the study was guided by previous studies[7,9,10] and Sousa and colleagues[13] assuming a 20% dropout rate. Patients younger than 18 yr or older than 80 yr, who had difficulty understanding the informed consent, and questionnaire, who had difficulty to speak or read Korean language, with poorly controlled psychiatric diseases that preclude cooperation, and with ASA physical status above 3 that could interfere with the outcome interpretation, were excluded. We did not limit the type of surgery, so that the performance of the QoR-15K in varied surgical settings could be assessed.

Translation and cultural adaption of the QoR-15 questionnaire

We performed the following three-step process to translate the original version into Korean before the initiation of the study process. First, two authors (SY and H-JL) translated the QoR-15 into Korean with reference to the Korean version of the QoR-40 (QoR-40K), which has been validated.[14] Second, one bilingual person (YMO), who had completed university education in the USA, translated the Korean version back into English. Third, three authors (SY, HJ, and H-JL) compared the original questionnaire with the reverse-translated questionnaire and assessed each item for its degree of concordance using a 7-point scale (1, no concordance; 7, perfect concordance). Any items that were scored between 5 and 7 points were adopted, whereas items that did not meet these criteria were subjected to a review process. The QoR-15K used in this study is available in Supplementary Figure S1.

Study protocol

The day before surgery, after informed consent was obtained, the patients were asked by the investigators to complete the QoR-15K as a measure of baseline status. Details of patient demographics, ASA physical status, history of surgery, presence of chronic pain, type of surgical procedure, the extent of surgery, and duration of surgery/anaesthesia (min) were also collected prospectively. The extent of surgery was classified as intermediate, major, and extra-major/complex according to the Surgical Outcome Risk Tool classification.[15]

Patients were then asked to repeat the questionnaire 24 (2) h postoperatively and also rate their overall postoperative recovery using a 100 mm visual analogue scale (global QoR VAS; where 0 denotes poor recovery and 100 indicates excellent recovery) and their resting pain using an 11-pointed numeric rating scale (NRS). All patients were asked to repeat the QoR-15K questionnaire 30–60 min later as a measure of test–retest reliability. Pre- and postoperative QoR-15K questionnaires were completed under the guidance of the investigator.

Statistical analysis

The normal distribution of the continuous variables was tested using the Shapiro–Wilk test and by examining the quantile–quantile plot. Normally distributed continuous variables were presented as the mean (standard deviation [SD]) and compared using a two-sample Student's *t*-test. When the distribution was not normal, median (inter-quartile range [IQR]) was presented and the groups were compared using a Mann–Whitney *U*-test between two independent groups or a Wilcoxon signed-rank test for paired data. Categorical variables are presented as frequency or percentage and were compared between groups using the χ^2 test or the Fisher's exact test, according to their expected counts. Correlations were measured using the Spearman correlation coefficient (ρ). The following are main analyses to evaluate the validity, reliability, responsiveness, and clinical acceptability of the QoR-15K, with reference to the previous publication.[5]

Firstly, we evaluated the three types of the validity of QoR-15K: convergent, construct, and discriminant validity. To

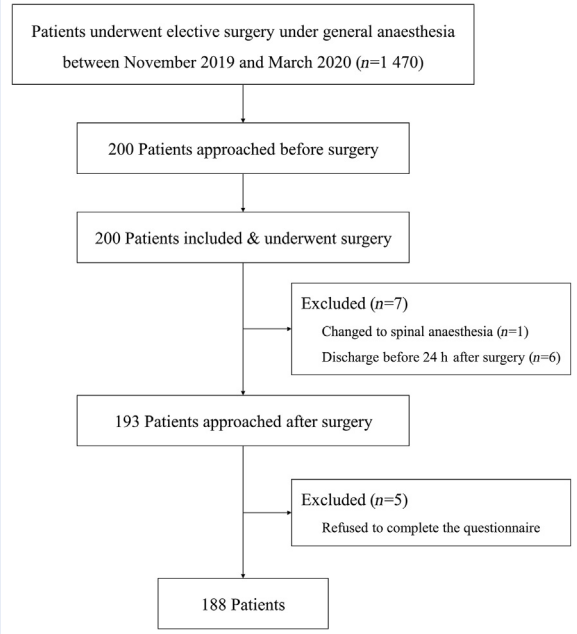

Fig 1. Study flowchart.

evaluate the convergent validity, we compared the postoperative QoR-15K with the global QoR VAS and measured the inter-item and -dimension correlations. We also measured the correlation between postoperative pain severity and the QoR-15K scores or dimensions to investigate the correlation of postoperative pain and recovery. Construct validity was tested by comparing the QoR-15K score according to age, sex, duration of surgery, and extent of surgery (intermediate + major *vs* extra-major/complex). Discriminant validity was tested by comparing the QoR-15K score in two groups divided by the global QoR VAS (≥70 mm [good] *vs* <70 mm [poor]).[5] We also assessed the validity of ΔQoR-15K score (postoperative − preoperative scores) as a sensitivity analysis during our revision process.

Secondly, reliability was measured for consistency of the QoR-15K. Reliability was assessed by internal consistency, split-half reliability, and test–retest reliability. Internal consistency was measured using Cronbach α and test–retest reliability was measured using the intra-class correlation coefficient (ICC).

Thirdly, responsiveness was measured using Cliff's effect size because of the non-normal distribution of the QoR-15K score. Cliff's effect sizes of 0.15, 0.33, and 0.47 correspond to small, medium, and large changes in the QoR-15K scores.[16] The median differences and 95% confidence intervals (CIs) between the pre- and postoperative QoR-15K scores were estimated with the Hodges–Lehmann method. Lastly, the clinical feasibility of the QoR-15K was evaluated with patient recruitment rate and successful completion rate.

R version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria) was used to analyse the data. A two-sided *P* value <0.05 was considered statistically significant for all analyses.

Subgroup analysis

We eventually plan to perform an RCT for ERAS in patients with VATS lung resection, which is the main type of surgery in our division. Because we expected the QoR-15K to be a useful primary outcome of ERAS, subgroup analysis only for the patients with unilateral VATS lung resection (lobectomy, segmentectomy, and wedge resection) was performed to obtain the information on the clinical status of this group. We also collected the duration of postoperative hospital stay and postoperative complications classified as the Clavien–Dindo classification within 1 week postoperatively.[17]

Results

From December 2019 to March 2020, we recruited 200 patients, and there were no refusals (recruitment rate: 100%). After recruitment, seven patients were excluded before postoperative follow-up and five patients refused to complete the QoR-15K after surgery (Fig. 1). A total of 188 patients completed it after surgery (completion rate: 97.4%). Patient and clinical characteristics are summarised in Table 1.

Convergent validity was assessed using the correlation between the postoperative QoR-15K score and the global QoR VAS, with ρ=0.61; 95% CI, 0.51–0.69; *P*<0.0001. The inter-item and -dimension correlation matrices of the postoperative QoR-15K are shown in Tables 2 and 3. There was a significant negative correlation between the QoR-15K score and the extent of surgery (ρ=−0.34; 95% CI, −0.46 to −0.21; *P*<0.001), the duration of surgery (ρ=−0.33; 95% CI, −0.45 to −0.19; *P*<0.001), or the severity of postoperative pain (ρ=−0.40; 95% CI, −0.52 to −0.28; *P*<0.001). The QoR-15K score differed significantly between the two groups divided by the surgical extent; intermediate + major, 109 (IQR, 88–124) *vs* extra-major/complex, 80 (IQR, 64–105.3), and median difference 23 (95% CI, 13 to 32), *P*<0.001. In addition, there was a significant correlation between the pre- and postoperative QoR-15K score (ρ=0.31; 95% CI, 0.17 to 0.43; *P*<0.0001). There was no correlation between the QoR-15K score and patient age (ρ=0.13; 95% CI, −0.01 to −0.27; *P*=0.08) and no difference in the postoperative QoR-15K score between men and women (ρ=−0.11; 95% CI, −0.25 to 0.03; *P*=0.14). The QoR-15K score differed significantly between two groups divided by the global QoR VAS; good (*n*=73), 122 (IQR, 104.5–133.3) *vs* poor (*n*=115), 92 (IQR, 67–105.8), median difference 29 (95% CI, 22–37), *P*<0.001. The results of validity assessment of the ΔQoR-15K score are shown in Supplemental material.

Inter-item Cronbach α were 0.84 and 0.90, and split-half reliabilities were 0.74 and 0.81 for QoR-15K at baseline and 24 h after surgery, respectively. The test–retest ICC was 0.95 (95% CI, 0.94–0.96). Inter-dimension Cronbach α were 0.66 and 0.81 at baseline and 24 h after surgery, respectively.

On postoperative day (POD) 1, the QoR-15K score decreased to 100 (IQR, 75–122) when compared with preoperative QoR-15K score 140 (IQR, 129–146), median difference −36.5 (95% CI, −41 to −32.5; *P*<0.0001; Table 4). The skewness and kurtosis values of the preoperative QoR-15K score were −1.41 and 1.70, respectively, and those of the postoperative QoR-15K scores were −0.25 and −0.89, respectively. Neither of them showed a normal distribution and floor or ceiling effects (Fig. 2). Cliff's effect size was −0.78 (95% CI, −0.84 to −0.71). Changes in perioperative health status and responsiveness of each item are summarised in Table 3. Among the item of the

postoperative QoR-15K, the 8th and 11th items had the lowest median score. The distribution of ΔQoR-15K score is shown in Supplementary Figure S2.

The result of the subgroup analysis in patients with VATS lung resection surgery is shown in Supplementary Tables S1 and S2, and Supplementary Figures S3 and S4. On POD 1, the QoR-15K score decreased to 111 (IQR, 96–123) when compared with preoperative QoR-15K score of 142 (IQR, 137–147). The correlation between the postoperative QoR-15 score and the global QoR VAS remained significant (with ρ=0.56; 95% CI, 0.38–0.70; $P<0.001$). There was a significant difference in the postoperative QoR-15K score between men and women; men, 116 (IQR, 103.5–132) *vs* women, 105 (IQR, 83.3–121.8), $P<0.01$. There was a significant difference in the duration of surgery between the two groups divided by the surgical extent; VATS wedge resection, 70 min (IQR, 34–91) *vs* VATS segmentectomy + lobectomy, 105 min (IQR, 90–121). However, the QoR-15K score in this cohort did not differ significantly between the two groups; VATS wedge resection, 106 (IQR, 101–122) *vs* VATS segmentectomy + lobectomy, 112 (IQR, 94–124), $P=0.995$. In this cohort, Cronbach α were 0.80 and 0.89, and split-half reliabilities were 0.67 and 0.85 for QoR-15K at baseline and 24 h after surgery, respectively; the test–retest ICC was 0.96 (95% CI, 0.94 to 0.97). Cliff's effect size was −0.84 (95% CI, −0.90 to −0.72). The median of the 8th and 11th items were also the lowest in this cohort.

Discussion

Our study demonstrates that the QoR-15K has excellent validity, consistent with the original QoR-15. The QoR-15K scores had a significant correlation with the patients' subjective postoperative recovery, the duration of surgery, and the extent of surgery. The internal consistency measured by Cronbach α and split-half reliability remained above-recommended levels (0.70–0.90),[18] and the responsiveness measured by Cliff's effect size suggest its strong ability to

Table 1 Patient characteristics and clinical characteristics. Data are presented as the median (inter-quartile range) or *n* (%). NRS, numeric rating scale

Variables	*n*=188
Female	93 (49.5)
Age (yr)	60 (52–66)
ASA physical status 1/2/3	43 (22.9)/130 (69.1)/15 (8.0)
Preoperative chronic pain	14 (7.4)
History of surgery	119 (63.3)
Surgical extent	
Intermediate	4 (2.1)
Major	123 (65.4)
Extra-major/complex	61 (32.4)
Type of surgery	
Thoracic surgery	103 (54.8)
General surgery	55 (29.3)
Gynaecological surgery	17 (9.0)
Urological surgery	10 (5.3)
Plastic surgery	3 (1.6)
Anaesthesia time (min)	153 (120–203)
Surgical time (min)	115 (85–160)
Postoperative pain severity (NRS)	4 (3–5)

Table 2 Inter-item correlation for the postoperative Korean version of Quality of Recovery-15 (QoR-15K) score and postoperative pain severity. Bold values are for $P<0.05$. VAS, visual analogue score; NRS, numeric rating scale

QoR-15K item	QoR VAS	Total score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Able to breathe easy	0.39	0.65	–														
2. Been able to enjoy food	0.51	0.71	0.34	–													
3. Feeling rested	0.50	0.83	0.61	0.59	–												
4. Have had a good sleep	0.36	0.67	0.47	0.38	0.68	–											
5. Able to look after personal toilet and hygiene unaided	0.50	0.71	0.38	0.70	0.54	0.38	–										
6. Able to communicate with family or friends	0.37	0.72	0.49	0.48	0.64	0.42	0.54	–									
7. Getting support from hospital doctors and nurse	0.29	0.54	0.39	0.33	0.52	0.28	0.24	0.66	–								
8. Able to return to work or usual home activities	0.48	0.71	0.34	0.58	0.51	0.34	0.64	0.45	0.25	–							
9. Feeling comfortable and in control	0.43	0.80	0.57	0.41	0.71	0.59	0.46	0.64	0.49	0.49	–						
10. Having a feeling of general well-being	0.48	0.79	0.53	0.48	0.66	0.50	0.45	0.54	0.40	0.54	0.73	–					
11. Moderate pain	0.47	0.55	0.37	0.27	0.49	0.42	0.29	0.28	0.23	0.32	0.36	0.33	–				
12. Severe pain	0.42	0.53	0.32	0.25	0.44	0.34	0.22	0.34	0.33	0.26	0.35	0.31	0.60	–			
13. Nausea or vomiting	0.25	0.45	0.28	0.25	0.27	0.22	0.28	0.38	0.23	0.27	0.24	0.34	0.20	0.25	–		
14. Feeling worried or anxious	0.21	0.57	0.34	0.21	0.41	0.35	0.18	0.38	0.37	0.27	0.55	0.52	0.26	0.27	0.26	–	
15. Feeling sad or depressed	0.25	0.60	0.40	0.26	0.40	0.29	0.20	0.43	0.41	0.30	0.56	0.59	0.22	0.29	0.32	0.75	–
Postoperative pain severity (NRS)	−0.43	−0.40	−0.30	−0.21	−0.27	−0.28	−0.25	−0.25	−0.15	−0.30	−0.29	−0.28	−0.45	−0.44	−0.30	−0.20	−0.14[a]

[a] $P = 0.06$.

Table 3 Inter-dimension correlation for the postoperative Korean version of Quality of Recovery-15 (QoR-15K) score and postoperative pain severity. Bold values are for $P<0.05$. VAS, visual analogue score; NRS, numeric rating scale

		QoR VAS	Total score	Physical comfort	Emotional state	Psychological support	Physical independence	Pain
QoR-15K dimension	Physical comfort	**0.58**	**0.93**	–				
	Emotional state	**0.43**	**0.84**	**0.69**	–			
	Psychological support	**0.36**	**0.72**	**0.64**	**0.60**	–		
	Physical independence	**0.55**	**0.79**	**0.73**	**0.52**	**0.48**	–	
	Pain	**0.48**	**0.61**	**0.51**	**0.41**	**0.37**	**0.34**	–
Postoperative pain severity (NRS)		**−0.43**	**−0.40**	**−0.36**	**−0.28**	**−0.22**	**−0.30**	**−0.28**

detect clinically important changes in postoperative recovery. The clinical feasibility was excellent. Our study indicates that QoR-15K is an acceptable method of assessing postoperative recovery in the acute postoperative period for Korean surgical patients.

Although the validity of QoR-40K had been established by other groups,[14] it might be difficult to apply this longer version in the acute postoperative period. In the original English version, the completion rates of the QoR-40 (87%) was lower than that of QoR-15 (95%) on POD 1.[5,6] The completion rate of QoR-40K on POD 3 was reported to be 87%,[14] and that of QoR-40K on POD 1 might be lower, as the completion rate is expected to increase further over time after surgery. In another study using the QoR-40 in Korean surgical patients, the refusal rate on POD1 was 3.8% (three/80). However, 14% (13/93) who were satisfied with the inclusion criteria refused to participate in the study, and the study included only relatively young female patients who underwent minor surgery.[19] In terms of clinical feasibility, the QoR-15K will be more useful in the acute postoperative period than the QoR-40K.

Our results showed the following different characteristics compared with the QoR-15 in other languages. First, the QoR-15K score did not show normal distribution.[5,9,20] Therefore, we used non-parametric statistics to analyse it as Lyckner and colleagues[7] have done. Second, the preoperative QoR-15K score was higher than that of the previous studies, and the items related to emotional problems (14th, 15th) had the lowest median among the QoR-15K items.[5,7,20] In our study, the proportion of patients with ASA physical status 3 was lower than in previous studies,[5,7,20] and almost all patients underwent cancer surgery. Therefore, emotional problems could be more pronounced in these patients. Third, the postoperative QoR-15K score showed a wider range compared with the previous studies. Within our hospital, protocols for perioperative fasting, postoperative pain management, and postoperative early ambulation varied considerably depending on the surgical division, which might have affected the degree of postoperative recovery. Anaesthesiologists, as leaders of perioperative medicine, should try to improve postoperative recovery, while reducing these differences based on the evidence.

We have also investigated the postoperative recovery evaluated by the QoR-15K in patients with VATS lung resection, as a preliminary study of our ERAS study in these patients. With the advances in medical technology, proving the significant effect of newer treatments will become increasingly difficult. The incidence of postoperative complications in these patients was significantly lower than those in other

Table 4 Change in the Korean version of Quality of Recovery-15 (QoR-15K) score before surgery and after surgery in the total cohort. Data are presented as the median (inter-quartile range), median difference (95% confidence interval [CI]), or Cliff's effect size (95% CI)

QoR-15K items	Preoperative	Postoperative	Median difference	Cliff's effect size
Total	140 (128–146)	100 (75–122)	−36.5 (−41 to −32.5)	−0.78 (−0.84 to −0.71)
1. Able to breathe easy	10 (9.5–10)	7 (5–9)	−2 (−2.5 to −2)	−0.62 (−0.70 to −0.53)
2. Been able to enjoy food	10 (10–10)	6.5 (0–10)	−4.5 (−5 to −3.5)	−0.64 (−0.71 to −0.56)
3. Feeling rested	10 (9–10)	7 (4.5–8)	−2.5 (−3 to −2)	−0.61 (−0.69 to −0.52)
4. Have had a good sleep	10 (8–10)	6 (4–8)	−2.5 (−3 to −2)	−0.57 (−0.62 to −0.47)
5. Able to look after personal toilet and hygiene unaided	10 (10–10)	6.5 (1–10)	−4.5 (−5 to −4)	−0.69 (−0.75 to −0.61)
6. Able to communicate with family or friends	10 (10–10)	9 (7–10)	−1.5 (−2 to −1)	−0.48 (−0.45 to −0.39)
7. Getting support from hospital doctors and nurse	10 (10–10)	10 (8–10)	−0.5 (−0.5 to 0)	−0.26 (−0.35 to −0.16)
8. Able to return to work or usual home activities	10 (10–10)	5 (1–7)	−5 (−5.5 to −4.5)	−0.81 (−0.86 to −0.74)
9. Feeling comfortable and in control	10 (8.5–10)	7 (5–9)	−2 (−2.5 to −1.5)	−0.51 (−0.60 to −0.41)
10. Having a feeling of general well-being	10 (7–10)	6.5 (3–8)	−2.5 (−3 to −2)	−0.49 (−0.58 to −0.39)
11. Moderate pain	10 (9–10)	5 (3–6)	−4.5 (−5 to −4)	−0.84 (−0.89 to −0.77)
12. Severe pain	10 (10–10)	7 (4.5–8)	−3.5 (−4 to −3)	−0.75 (−0.81 to −0.67)
13. Nausea or vomiting	10 (10–10)	9 (7–10)	−1.5 (−2 to −1)	−0.45 (−0.53 to −0.36)
14. Feeling worried or anxious	8 (6–10)	8 (5.5–10)	0 (−0.5 to 0.5)	0.02 (−0.10 to 0.13)
15. Feeling sad or depressed	8 (7–10)	8.5 (6–10)	0 (−0.5 to 0.5)	0.03 (−0.08 to 0.14)

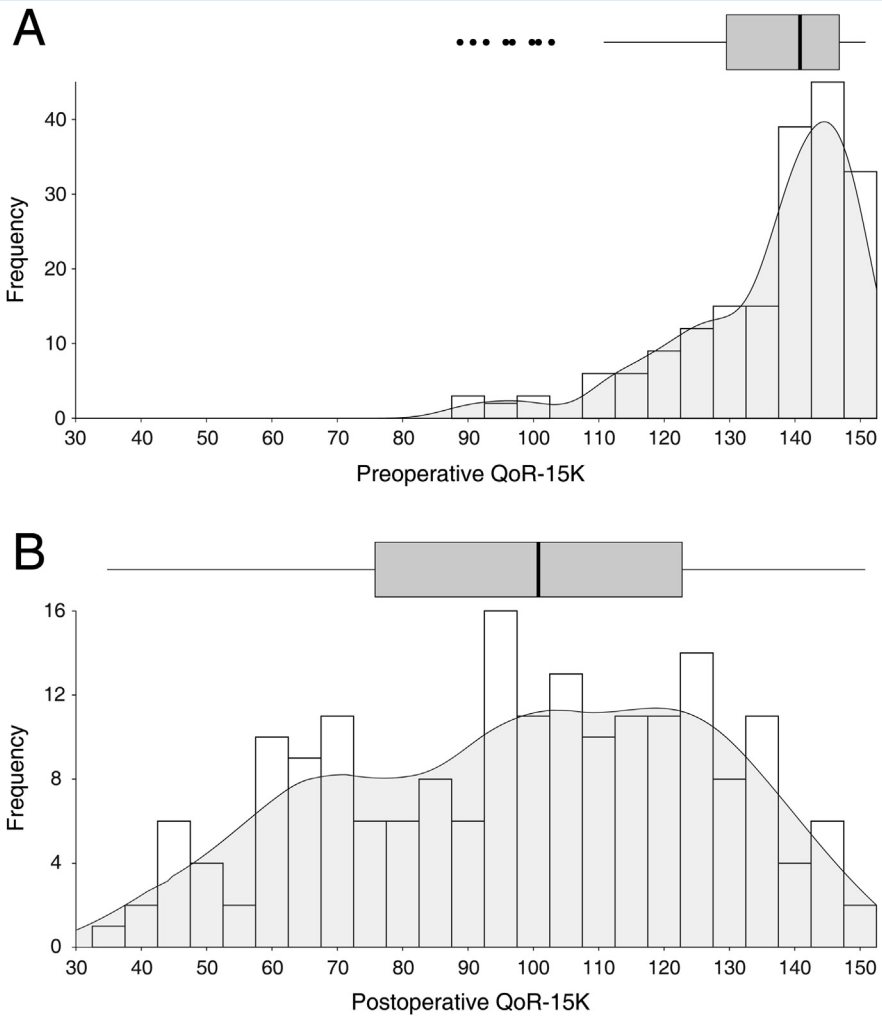

Fig 2. Box-and-whisker plot, histogram and kernel density plot (solid curve) of the pre- (a; n=188) and postoperative (b; n=188) Korean version of the Quality of Recovery-15 (QoR-15K) scores in the total cohort. Box plot shows the median and inter-quartile range of QoR-15K scores. Right and left whiskers denote maximum and minimum values excluding outliers, respectively. Round symbols show the outliers.

studies.[21] The length of postoperative hospital stay was not long compared with that of previous ERAS studies.[22,23] Nevertheless, we should continue to explore the effects of various components of ERAS such as preoperative optimisation and multimodal analgesic techniques, not yet introduced in our hospital. Against this backdrop, we have been interested in the QoR-15, and we thought that there was still room for improvement in postoperative recovery evaluation with the QoR-15K.

Our subgroup analysis gave the information on what we should focus more on while establishing our ERAS protocol in these patients. Among the 15 items of the postoperative QoR-15K, the median scores of the 8th (able to return to work or usual home activities) and 11th (moderate pain) items were the lowest, and those of the 4th (have had a good sleep), 10th (having a feeling of general well-being), and 12th (severe pain) items were lower than those of other items. We noted the effects of postoperative pain on postoperative recovery because it may adversely impact the patient's quality of life in the acute postoperative period.[24,25] Poorly controlled postoperative pain may adversely affect postoperative physical functioning and psychological status, and contribute to sleep disturbances[26–28]; this has been observed in our results as well. Therefore, the improvement of postoperative pain will improve the overall postoperative recovery. In addition, even within the same surgery, there was still considerable individual difference in postoperative recovery. Further studies regarding perioperative factors affecting postoperative recovery using tools such as the QoR-15 are warranted.

In this study, we found a few problems with the QoR-15. First, some of the patients were confused with the change in the scale definition between parts I and II, which was also pointed out in the French version.[20] Part II has a low score of the QoR-15 indicating severe pain in contrast to the NRS pain score, which is more familiar to patients. Thus, the investigators had to help those patients understand the scale clearly. Second, the pain or postoperative nausea/vomiting assessment in QoR-15 was about frequency, but some patients

confused it with intensity. Lastly, there have been a few patients complaining of the difficulty in accurately distinguishing the expression of 'moderate pain' and 'severe pain'. As a result, the investigator had to explain to these patients, 'moderate pain' as 'tolerable pain' and 'severe pain' as 'non-tolerable pain'. Translations of the QoR-15 only by the authors of this study, without a non-medical bilingual translator, may have led to this lack of subtle linguistic–cultural validity in the QoR-15K. Further modifications are necessary to rectify these problems.

There are several limitations to this study. Our results were obtained from a single tertiary university hospital, and the surgical procedures were mainly limited to major surgeries. Therefore, the QoR-15K may require further validation before it can be generalised to other clinical settings and minor and intermediate surgeries. Second, we enrolled three or four patients per day who were scheduled for elective surgery in our division and anticipated admission to PACU during the daytime. This raises the possibility of selection bias. Third, the QoR-15K was only measured on POD 1 without further serial assessment. As a patient's mental and physical status undergo rapid changes during the acute postoperative phase, changes in QoR-15K throughout the postoperative hospital stay may have more clinical implications than a single measurement.

In conclusion, our study showed that the QoR-15K is valid, and has excellent reliability, a high degree of responsiveness, and clinical feasibility as a measurement of quality of recovery in a Korean surgical population. We believe that the QoR-15K is suitable as an outcome measure in the era of ERAS.

Authors' contributions

Study design: H-JL
Data collection: SY, HJ, YMO
Statistical analysis: JL, H-JL
Manuscript preparation: SY, H-JL
Manuscript revision: SY, J-HB, H-JL

Declarations of interest

The authors declare that they have no conflict of interest.

Funding

This study was supported by a grant from the Seoul National University College of Medicine Research Foundation (800-20200318).

Acknowledgements

We have obtained the permission from *Anesthesiology*, which owns the copyright of the original version of the QoR-15. We thank Editage (www.editage.co.kr) for English language editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2020.06.040.

References

1. Lee L, Tran T, Mayo NE, Carli F, Feldman LS. What does it really mean to "recover" from an operation? *Surgery* 2014; **155**: 211–6
2. Miller TE, Mythen M. Successful recovery after major surgery: moving beyond length of stay. *Perioper Med* 2014; **3**: 4
3. Abola RE, Bennett-Guerrero E, Kent ML, et al. American Society for Enhanced Recovery and Perioperative Quality Initiative joint consensus statement on patient-reported outcomes in an enhanced recovery pathway. *Anesth Analg* 2018; **126**: 1874–82
4. Bowyer A, Jakobsson J, Ljungqvist O, Royse C. A review of the scope and measurement of postoperative quality of recovery. *Anaesthesia* 2014; **69**: 1266–78
5. Stark PA, Myles PS, Burke JA. Development and psychometric evaluation of a postoperative quality of recovery score. The QoR-15. *Anesthesiology* 2013; **118**: 1332–40
6. Myles P, Weitkamp B, Jones K, Melick J, Hensen S. Validity and reliability of a postoperative quality of recovery score: the QoR-40. *Br J Anaesth* 2000; **84**: 11–5
7. Lyckner S, Böregård IL, Zetterlund EL, Chew M. Validation of the Swedish version of Quality of Recovery score-15: a multicentre, cohort study. *Acta Anaesthesiol Scand* 2018; **62**: 893–902
8. Bu X-S, Zhang J, Zuo Y-X. Validation of the Chinese version of the quality of recovery-15 score and its comparison with the post-operative quality recovery scale. *Patient* 2016; **9**: 251–9
9. Kleif J, Edwards H, Sort R, Vilandt J, Gögenur I. Translation and validation of the Danish version of the postoperative quality of recovery score QoR-15. *Acta Anaesthesiol Scand* 2015; **59**: 912–20
10. Sá AC, Sousa G, Santos A, Santos C, Abelha FJ. Quality of recovery after anesthesia: validation of the Portuguese version of the "Quality of Recovery 15" Questionnaire. *Acta Med Port* 2015; **28**: 567–74
11. Jammer I, Wickboldt N, Sander M, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions A statement from the ESA–ESICM joint taskforce on perioperative outcome measures. *Eur J Anaesthesiol* 2015; **32**: 88–105
12. Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Int J Surg* 2014; **12**: 1495–9
13. Sousa VD, Rojjanasrirat W. Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: a clear and user-friendly guideline. *J Eval Clin Pract* 2011; **17**: 268–74
14. Lee JH, Kim D, Seo D, Son J-S, Kim D-C. Validity and reliability of the Korean version of the Quality of Recovery-40 questionnaire. *Kor J Anesthesiol* 2018; **71**: 467
15. Protopapa K, Simpson J, Smith N, Moonesinghe S. Development and validation of the surgical outcome risk tool (SORT). *Br J Anaesth* 2014; **101**: 1774–83
16. Romano J, Kromrey JD, Coraggio J, Skowronek J. *Appropriate statistics for ordinal level data: should we really be using t-test and Cohen's d for evaluating group differences on the NSSE and other surveys?*. Florida: Annual meeting of the Florida Association of Institutional Research; 2006. p. 14–5

17. Clavien PA, Barkun J, De Oliveira ML, et al. The Clavien–Dindo classification of surgical complications: five-year experience. *Ann Surg* 2009; **250**: 187–96
18. McDowell I. *The theoretical and technical foundations of health measurement. Measuring Health: a guide to rating scales and questionnaires*. USA: Oxford University Press; 2006. p. 10–46
19. Lee W-K, Kim M-S, Kang S-W, Kim S, Lee J-R. Type of anaesthesia and patient quality of recovery: a randomized trial comparing propofol–remifentanil total iv anaesthesia with desflurane anaesthesia. *Br J Anaesth* 2015; **114**: 663–8
20. Demumieux F, Ludes P-O, Diemunsch P, et al. Validation of the translated Quality of Recovery-15 questionnaire in a French-speaking population. *Br J Anaesth* 2020; **124**: 761–7
21. Hwang Y, Kang CH, Kim H-S, Jeon JH, Park IK, Kim YT. Comparison of thoracoscopic segmentectomy and thoracoscopic lobectomy on the patients with non-small cell lung cancer: a propensity score matching study. *Eur J Cardiothorac Surg* 2015; **48**: 273–8
22. Huang H, Ma H, Chen S. Enhanced recovery after surgery using uniportal video-assisted thoracic surgery for lung cancer: a preliminary study. *Thorac Canc* 2018; **9**: 83–7
23. Gonzalez M, Abdelnour-Berchtold E, Perentes JY, et al. An enhanced recovery after surgery program for video-assisted thoracoscopic surgery anatomical lung resections is cost-effective. *J Thorac Dis* 2018; **10**: 5879
24. Wu CL, Naqibuddin M, Rowlingson AJ, Lietman SA, Jermyn RM, Fleisher LA. The effect of pain on health-related quality of life in the immediate postoperative period. *Anesth Analg* 2003; **97**: 1078–85
25. Wu CL, Rowlingson AJ, Partin AW, et al. Correlation of postoperative pain to quality of recovery in the immediate postoperative period. *Reg Anesth Pain Med* 2005; **30**: 516–22
26. Miller A, Roth T, Roehrs T, Yaremchuk K. Correlation between sleep disruption on postoperative pain. *Otolaryngol Head Neck Surg* 2015; **152**: 964–8
27. Chouchou F, Khoury S, Chauny J-M, Denis R, Lavigne GJ. Postoperative sleep disruptions: a potential catalyst of acute pain? *Sleep Med Rev* 2014; **18**: 273–82
28. Perlas A, Kirkham KR, Billing R, et al. The impact of analgesic modality on early ambulation following total knee arthroplasty. *Reg Anesth Pain Med* 2013; **38**: 334–9

Handling editor: Paul Myles