Acta Orthop. Belg., 2008, **74**, 360-364

ORIGINAL STUDY

ASA physical status classification is not a good predictor of infection for total knee replacement and is influenced by the presence of comorbidities

Geert Peersman, Richard Laskin, John Davis, Margareth G. E. Peterson, Tom Richart

From the Hospital for Special Surgery, New York, New York, USA

The American Society of Anesthesiologists Physical Status Classification System (ASA) ranks patients for risk of adverse events during a surgical procedure. The ASA classification is used as a surrogate for the patient's underlying severity of illness and has been recommended for use in Surgical Site Infection (SSI) and risk stratification. We assessed the predictive power of the ASA score for total knee replacement surgery infection, and compared it to a comorbidity score. All patients who had TKA (total knee arthroplasty) surgery performed during the period of 1993 to 1999 at one institution were identified. One hundred and thirteen infected cases were matched with 236 controls and nominal variables were statistically processed. A total co-morbidity score (TCOMORBID) was created to help the analysis. All possible predictors of infection were tested against infection in bivariate analysis. The association of the ASA score with infection was examined in detail. An ASA score beyond 2 showed an increased risk of infection. The average ASA score for the infected TKA group was 2.3 ± 0.6, and the non-infected TKA average score was 2.6 ± 0.7 (cohort effect). The relationship between the ASA score and TCOMORBID score was poor ; Spearman rank correlation rho = 0.2, (p < 0.0001). In fact, the ASA score predicted only 6% of the occurrences of infection, but since it predicts 98% of the cases where there is no infection correctly, it is 70% accurate over all. Infection in TKA surgery was associated with an increased ASA score, but only when the high ASA score was due to a combination of specific co-morbidities. We propose that the ASA score should be cross-checked with the current co-morbidities, like rheumatoid arthritis or active infections in order to assess TKA infection risk.

Keywords : TKA infection ; SSI risk stratification ; ASA score.

INTRODUCTION

The American Society of Anesthesiologists Physical Status Classification System, (ASA), ranks patients for risk of adverse events during a surgical procedure. The ASA classification is used as a surrogate for the patient's underlying severity of illness and has been recommended for use in

■ Geert Peersman, MD, Orthopaedic Surgeon.
■ Tom Richart, MD, MSc, Fellow.
Ziekenhuis Netwerk Antwerpen, Campus Stuivenberg, Antwerp, Belgium.
■ Richard Laskin, MD, Orthopaedic Surgeon, Professor of Orthopaedic Surgery.
■ John Davis, RN, Orthopaedic Nurse.
■ Margareth Peterson, PhD, Statistician.
The Hospital for Special Surgery, Weill Medical School of Cornell University, New York, NY, USA.
Correspondence : Geert Peersman, Department of Orthopaedic Surgery, ZNA Stuivenberg, Lange Beeldekensstraat 267, 2060 Antwerpen, Belgium.
E-mail : geert.peersman@telenet.be

No benefits or funds were received in support of this study

Table I. — The ASA scoring system

Code	Patient Pre-operative Physical Status
1	Normally healthy patient
2	Patient with mild systemic disease
3	Patient with severe systemic disease that is not incapacitating
4	Patient with an incapacitating systemic disease that is a constant threat to life
5	Moribund patient who is not expected to survive for 24 hours with or without operation

Surgical Site Infection (SSI) and risk stratification (*1,2*). The ASA score ranges from 1 to 5 and is felt to be predictive of potential surgical complications (table I lists the 5 ASA scores and their respective criteria).

Since infection is one of the major complications of knee replacement surgery, it would appear intuitive that the ASA score could be used to predict infection. To our knowledge, the association of the ASA score with the risk of infection after total knee replacement surgery has not been assessed before. Here, we assess the association between the ASA score and the risk of post-operative infection in a retrospective analysis of patients who underwent total knee replacement (TKA).

METHODS

Patient selection

All patients who had TKA surgery performed during the period of 1993 to 1999 at one institution were identified. An infected TKA subset list within this same timeframe was also determined and reviewed. Three patients identified had records that were unavailable. These patients' data was not retrieved, so they were excluded. For each infected case, two controls were selected. The controls were non-infected TKA patients, with surgery performed in the same year and month, matched for gender and age. As described before (3), eighty data items including diagnosis, co-morbid conditions, other risk factors, ASA scores, surgical time, antibiotic coverage, and other general demographics were collected from each record and electronically entered via handheld personal data assistant (PDA) to a Microsoft Excel database for analysis.

A total of 6489 TKA procedures were identified with 113 of these listed as infected. From the 113 infected cases, 20 surgeries were done prior to 1993 and diagnosed as infected during the period of 1993 to 1999.

Preoperative evaluation and perioperative management

Each patient scheduled for surgery was seen preoperatively for medical clearance by an anesthesiologist who assessed the ASA score. In addition to optimizing the patient's general medical status, particular attention was paid to eliminating sources of potential bacterial contamination (skin, oral, and urinary etc.). The patients were admitted to the hospital on the day of surgery. The surgical site was washed by the patient with anti-microbial soap (povidone-iodine solution) the night prior to admission and then shaved and washed again immediately prior to surgery. Intravenous antibiotics were administered within 30 minutes of the surgical incision. Until 1995, patients were routinely maintained on antibiotics for 48 hours. After 1995, the protocol was changed to coverage for only 24 hours. A first generation cephalosporin (cefazolin 1 gm every 8 hours) was the routine prophylaxis. In cases of known penicillin or cephalosporin allergy, Vancomycin 500 mg every 12 hours was administered. Closed suction wound drainage was used for the first 24 hours after surgery.

Statistics and Data analysis

For database management and statistical analysis, we used SAS software, version 9.1.3 and JMP, version 6 (SAS Institute, Cary, NC, U.S.A.). To help the statistical analysis, a total co-morbidity score (TCOMORBID) was created. Each co-morbidity factor added 1 point to the total score. The co-morbid conditions identified and recorded are listed in table III. Patient TCOMORBID scores ranged from 0 to 10. The non-infected cases never scored higher than 4. All possible predictors of infection were tested against infection in bivariate analysis. The association of the ASA score with infection was examined in detail. Logistic regression with infection as the dependent variable was subsequently performed.

RESULTS

Table II lists the demographic information of the patients. There were no significant differences in age, height or body weight between infected

Table II. — Demographic information

	All (n = 349)	Infected (n = 113)	Not-Infected (n = 236)	p
Sex*				
Female	213	70	143	NS
Male	136	43	93	NS
Age (years)	64.4 ± 13.2	62.7 ± 15.3	65.2 ± 11.9	0.09
Height (cm)	168.34 ± 11.1	167.1 ± 10.9	168.9 ± 11.2	0.05
Weight (kg)	85.2 ± 23.7	88.4 ± 26.2	83.6 ± 22.2	0.08
Co-morbidities				
No	53	4	49	< .0001
Yes	296	109	187	< .0001

Values are means ± SD
p-values for differences between infected and non-infected cases
* No significant differences exist for sex-specific infection risks.

and non-infected cases. The infected group had a significantly higher incidence of comorbidities. The variables that were used for the TCOMORBID-score are shown in table III. Diabetes, immunosuppressive medications, infections elsewhere (see table III for details), poor nutrition, renal failure, smoking, alcohol use, obesity, prior open surgery and revision surgery were significantly ($p < 0.05$) associated with the occurrence of infection.

The association between ASA score and occurrence of infection was examined more closely. The data are shown in table IV. No patient had an ASA score greater than 4 on the scale. The relationship between the ASA score and TCOMORBID score was poor. The Spearman rank correlation was poor, rho = 0.2, ($p < 0.0001$). Although those with an ASA score of 1 never had more than 3 co-morbidities, the patients with 0 comorbidities had ASA scores recorded as 2 and above.

Using stepwise logistic regression with the occurrence of infection as the dependent variable, the ASA score always dropped out, or never entered into the equation. Other variables such as weight, number of comorbidities and diagnosis were always stronger predictors and more closely associated with occurrence of infection. In fact, the ASA score predicted only 6% of the occurrences of infection, but since it predicts 98% of the cases where there is no infection correctly, it is 70% accurate over all.

DISCUSSION

Mangram *et al* stated, "The usefulness of a variable depends on how accurately it is reported" *(2)*. They indicated that predictors may not be the same for all operations and therefore should be examined for specific operations. Salemi *et al* examined the accuracy of the ASA score in 250 prosthetic joint surgeries *(4)*. They found ASA scoring discrepancies in 59% of 113 ASA Class 3 surgeries. This is a high rate of error and gives cause for concern. When correcting 2 of 10 for ASA discrepancy and surgical site infection errors, the SSI rate dropped from 5.8 per 100 surgeries to 4.5 per 100 surgeries *(4)*. This indicates a significant effect of ASA scoring error.

Grosflam *et al* examined predictors of blood loss during total hip replacement surgery and found the ASA score predicted greater blood loss both in univariate and multivariate analysis. The important level was having an ASA score of 3 *(1)*. When reviewing coronary artery bypass surgery, Wang and Chang found univariate analysis of the ASA score predicted deep sternal wound infections *(5)*. However, in multivariate analysis, only the re-operation for bleeding and operation time were predictors *(5)*. Wischnewski *et al* studied the prevalence and risk factors of nosocomial wound infections in all surgeries and found that an ASA > 3 was not

Table III. — Comorbidities of infected/control patients

Comorbidities	Infected (n = 113)	Non-infected (n = 236)	p
Infections (dental, respiratory, dermatological, distal ulcers, diverticulitis)	4	0	< .0001*
Prior surgery			
Open surgery	28	26	0.0014*
Arthroscopic surgery	20	41	NS
Revision surgery	5	13	0.0042*
Duration of surgery			
Malignant disease	16	24	0.29
Vascular disease	32	65	0.90
Chronic renal failure	5	2	0.04*
Diabetes	18	16	0.0112*
Psoriasis	3	4	0.6844
Neuropathy	2	1	0.2459
Smoking	11	8	0.0216*
Alcohol abuse	9	6	0.0253*
Obesity	46	64	0.0136*
Poor nutrition	9	1	0.0002*
Immunosuppressive therapy	20	14	0.0009*

Comorbidities used to calculate the TCOMORBID-score.
p-values are for differences between infected/non-infected groups, using Mann-Whitney test
The presence of one of the comorbidities added 1 to the total TCOMORBID score.

Table IV. — ASA score and infection percentage

ASA Score	Infected (%)	Non-infected (%)
1	4 (3.54)	15 (6.36)
2	46 (40.71)	151 (63.98)
3	56 (49.56)	67 (28.39)
4	7 (6.19)	3 (1.27)
5	0	0

Values are absolute numbers and percentages.

associated with wound infection and that wound contamination was the single most important factor (*6*). Further, Wolters *et al* looked at all complications after general surgeries in a multivariate analysis and again found an ASA score ≥ 3 was a significant factor (*7*).

Three categories of variables have proven to be reliable predictors of SSI risk : (1) those that estimate the intrinsic degree of microbial contamination of the surgical site, (2) those that measure the duration of an operation and (3) those that serve as markers of host susceptibility (*1*). The degree of microbial contamination of the surgical site was relatively constant in the studied population because all patients were treated according to the standardized protocol as mentioned in the method section. We assessed the association of the duration of knee replacement surgery and the risk of infection before (*3*). We demonstrated that prolonged operation time significantly correlated with infection risk, as well as with BMI and the total number of comorbidities. As for host susceptibility factors, we found the ASA score not to be a good predictor compared to the number of comorbidities.

However, the prevalence of infections does increase with higher ASA scores, but since most of our patients' scores were below 3, we were unlikely to replicate Grosflam's findings that an ASA score > 3 was a good predictive factor (*1*). It is the small number of patients with an ASA score > 3 in this usually non-emergency surgical population, that lowers this variable's possible power as a predictor. An ASA score beyond 2 showed an increased risk of infection. In our current analysis, the average ASA score for the infected TKA group was 2.3 ± 0.6, and the non-infected TKA average score was 2.6 ± 0.7. Thus, the non-infected TKA had a higher average ASA score. This counter-intuitive result can be explained by the fact that the cohort control group had a higher number of patients included. Only few of these patients were of normal health and thus presented with an ASA score > 1. The difference was very small and certainly not clinically significant.

The current results must be interpreted taking the possible limitations of the study into account. We did not apply corrections for observers that scored the ASA in individual patients, because this information was not available for the majority of the patients. The possible observer error for the ASA score was thus not taken into account.

CONCLUSION

Our study showed infection in TKA surgery was associated with an increased ASA score, but only when the high ASA score was due to a combination of specific co-morbidities previously mentioned. A high ASA score due to cardiovascular, respiratory or neurological disorders was not representative of a higher infection risk. The Spearman's rank test showed a weak association between infection and the ASA score. We found the ASA classification by itself to be a poor predictor of infection or an unreliable predictor of infection in total knee replacement surgery. We propose that the ASA score should be cross-checked with the current co-morbidities, like rheumatoid arthritis or active infections in order to better assess individual patients' TKA infection risk.

REFERENCES

1. **Grosflam JM, Wright EA, Cleary PD, Katz JN.** Predictors of blood loss during total hip replacement surgery. *Arthritis Care Res* 1995 ; 8 : 167-173.
2. **Mangram AJ**, **Horan TC, Pearson ML *et al.*** Guideline for prevention of surgical site infection, 1999. *Am J Infect Control* 1999 ; 27 : 97-132.
3. **Peersman G, Laskin R, Davis J, Peterson M.** Infection in total knee replacement : a retrospective review of 6489 total knee replacements. *Clin Orthop* 2001 ; 392 : 15-23.
4. **Salemi C, Anderson D, Flores A.** American Society of Anesthesiology, scoring discrepancies affecting the National Nosocomial Infection Surveillance System : surgical-site-infection risk index rates. *Infect Control Hosp Epidemiol* 1997 ; 18 : 246-247.
5. **Wang FD, Chang CH.** Risk factors of deep sternal wound infections in coronary artery bypass surgery. *J Cardiovascular Surg* 2000 ; 41 : 709-713.
6. **Wischnewski N, Kampf G, Gastmeier P *et al.*** Nosocomial wound infections : a prevalence study and analysis of risk factors. *Int Surg* 1998 ; 83 : 93-97.
7. **Wolters U, Wolf T, Stutzer H *et al.*** Risk factors, complications and **outcome** in surgery : a multivariate analysis. *Eur J Surg* 1997 ; 163 : 563-568.