



Readmissions and mortality after outpatient vs inpatient unicompartmental knee arthroplasty in Denmark – A propensity score matched study of 5,384 procedures

Kristine B. Arndt ^{a,*}, Claus Varnum ^b, Martin Lindberg-Larsen ^a, Christian B. Jensen ^c, Lasse E. Rasmussen ^b

^a Department of Orthopaedic Surgery and Traumatology, Odense University Hospital; Department of Clinical Research, University of Southern Denmark, Odense; J. B. Winsløvs Vej 4, 5000 Odense, Denmark

^b Department of Orthopaedic Surgery, Lillebaelt Hospital – Vejle; Beriderbakken 4, 7100 Vejle, Denmark

^c Department of Orthopaedic Surgery, Clinical Orthopaedic Research Hvidovre, Copenhagen University Hospital Hvidovre, Denmark, Kettegård Alle 30, 2650 Hvidovre, Denmark

ARTICLE INFO

Article history:

Received 16 April 2022

Accepted 15 July 2022

Keywords:

Unicompartmental knee arthroplasty

Knee arthroplasty

Readmission

Outpatient surgery

ABSTRACT

Background: Limited nationwide data on the development of outpatient unicompartmental knee arthroplasty (UKA) practice and patient safety exist. The primary objective of this study on patients receiving a medial or lateral UKA was to investigate 7-, 30- and 90-day readmission risk and 90-day mortality in outpatient vs inpatient surgeries. Secondary to investigate the nationwide development of outpatient UKA surgery in 2014–2018.

Methods: Included patients received a medial or lateral UKA in the period January 1, 2014 to December 31, 2018 in any Danish hospital. Data were collected from the Danish National Patient Register. The cohort consisted of 1,059 outpatient and 4,325 inpatient surgeries, hereof 5,182 medial and 202 lateral UKA. After propensity score matching (1:1) 1,057 patients were included in each group.

Results: We found a 7-day readmission risk of 1.5 % vs 1.4 % ($p = 0.8$), 30-day readmission risk of 2.6 % vs 3.2 % ($p = 0.3$), and 90-day readmission risk of 4.2 % vs 4.8 % ($p = 0.4$) after outpatient vs inpatient UKA. Similar results were found after matching. We found no significant differences in 90-day mortality for the unmatched or matched cohorts. The amount of outpatient UKA surgeries in Denmark increased from 86 in 2014 to 214 in 2018.

Conclusion: Outpatient medial or lateral UKA seem to be as safe as inpatient UKA on a nationwide basis.

© 2022 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Fast-track hip and knee arthroplasty has been introduced worldwide resulting in improved patient satisfaction, faster recovery and cost-effectiveness [1–3]. The safety of fast-track programs with ≥ 1 day of hospitalization is well investigated

* Corresponding author at: J. B. Winsløvs Vej 4, 5000 Odense, Denmark.

E-mail address: kristine.bollerup.arndt@rsyd.dk (K.B. Arndt).

and studies report no increased morbidity or mortality [4,5]. However, fast-track programs require a multidisciplinary effort and strict discharge criteria to be followed [6].

Outpatient unicompartmental knee arthroplasty (UKA) surgery protocols have been implemented at several Danish hospitals as a part of well-established fast-track programs [3]. Concerns about the safety of outpatient surgery has been raised, after studies based on the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database have shown higher odds of complications after outpatient total hip arthroplasty (THA) and total knee arthroplasty (TKA) compared to inpatient THA and TKA [7–10]. Similar readmission and complication risks after outpatient vs inpatient THA and TKA have been found in a Danish study [11]. The safety of outpatient UKA remains unknown. Therefore, the primary objective of this study on patients receiving a medial or lateral UKA was to investigate 7-, 30- and 90-day readmission risk and 90-day mortality in outpatient vs inpatient surgeries. Secondary to investigate the nationwide development of outpatient UKA surgery in 2014–2018.

2. Patients and methods

This was a retrospective cohort study of nationwide collected data. The RECORD guidelines for the reporting of routinely collected, observational data were followed [12].

2.1. Data sources

We retrieved information on surgical procedure codes, somatic diagnosis codes, age and sex from the Danish National Patient Register (DNPR). The DNPR is a national administrative register collecting information on all public and private hospital contacts in Denmark since 1977. Danish hospitals receive reimbursement from the health authorities when reporting to the DNPR ensuring a completeness of > 99 % [13]. We used the Charlson Comorbidity Index (CCI) to estimate the burden of comorbidities for each patient [14,15]. The CCI was calculated from ICD-10 codes for the 10-year period up to the date of surgery [14,15]. The burden of comorbidities was classified into three levels: CCI of 0 (low), CCI of 1–2 (medium), and CCI of 3 or more (high). We collected information on cohabitation and death from the Danish Civil Registration System (CPR), which is a national register containing basic personal information on all who have a civil registration number. Cohabitation was categorized binary as patients being married or cohabiting vs unmarried, widowed or divorced.

2.2. Patients

All included patients received a medial or lateral UKA in the period January 1, 2014 to December 31, 2018. We identified 6,162 patients in the DNPR from the procedure codes KNGB01 (uncemented medial UKA), KNGB02 (uncemented lateral UKA), KNGB11 (cemented medial UKA) and KNGB12 (cemented lateral UKA) registered according to the Nordic Medico-Statistical Committee (NOMESCO) classification of surgical procedures (Figure 1) [16]. Outpatient surgery did not include an overnight stay and inpatient surgery included length of stay (LOS) of 1–3 days postoperatively. Patients were excluded if LOS was more than 3 days, because prolonged stay indicated unusual circumstances making the patients unsuited for inclusion. The later surgery was excluded for patients receiving bilateral UKA.

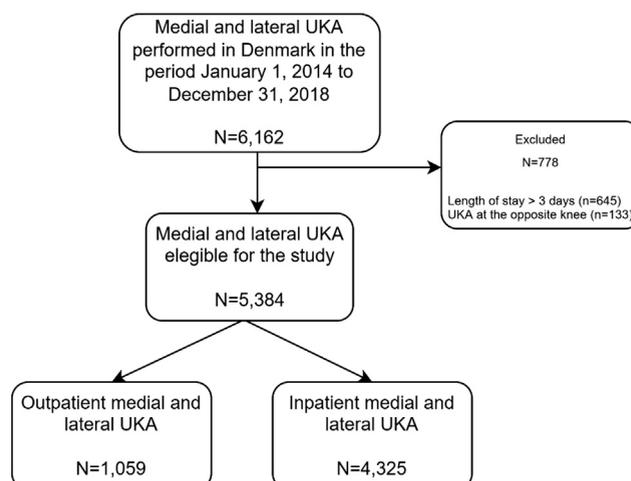


Figure 1. Flowchart of inclusion of the total unmatched cohort. UKA = unicompartmental knee arthroplasty.

2.3. Outcome measures

We obtained ICD-10 diagnosis codes for readmissions from the DNPR within 7, 30 and 90 days after discharge. A readmission was defined as a new admission with overnight stay in hospital. The diagnosis codes listed in Appendix A were considered potentially related to the index surgery. Obviously unrelated readmissions (e.g. G44.8: Other specified headache syndrome; D12.3: Benign neoplasm of transverse colon) listed in Appendix B were excluded. Only first-time readmissions after surgery were included.

2.4. Statistics

Data were presented as counts and risk estimated as proportions. Continuous data were assessed using Students t-test and nominal variables were assessed using Pearson chi-squared test. Continuous data were inspected for normal distribution with Q-Q plots. We used propensity score matching to control for potential confounders. We estimated the propensity score with a multivariable logistic regression model for the 5,384 patients eligible for this study. The groups were matched according to patients undergoing outpatient or inpatient surgery. We used 1:1 nearest neighbor matching with a caliper of 0.2, discarding units out of common support and sampling without replacement [17]. Age, sex, cohabitation, CCI and type of UKA were set as matching variables. We investigated the matched and unmatched groups for imbalance of the matching variables with standardized mean differences (SMD) (Table 1) [18]. A SMD > 0.1 indicated imbalance. The outcome of the propensity score model was average treatment effect of the treated (ATT) and statistical significance was reported with p-values. Statistical significance was set at the 5 % level. For all analyses, we used Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC.

2.5. Ethics

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Danish Data Protection Agency (Journal no. 19/14416). Ethical approval was not needed as the study was non-interventional. Declarations of interest: none.

3. Results

We identified 5,384 patients receiving a medial or lateral UKA, 5,182 and 202 respectively; 1,059 outpatient UKA and 4,325 inpatient UKA surgeries with LOS of 1–3 days, mean LOS 1.4 (CI 1.4–1.5) (Figure 1). After propensity score matching 1,057 patients were included in each group and no indications of imbalance were present between groups (Table 1).

Risk of readmission were similar for in- and outpatient UKA after 7, 30 or 90 days for both the unmatched and the matched cohorts (Table 2). Mortality risk within 90 days were similar between groups as well (Table 2).

The nationwide cohort included 27 centers, 19 of which performed both in- and outpatient UKA. Overall 19 % of UKA's performed in 2014–2018 in Denmark were outpatient surgeries, with an increase during the study period. 86 outpatient

Table 1
Demographic matching characteristics.

Characteristic	Pre-Matching			Post-Matching		
	Outpatient N = 1,059	Inpatient N = 4,325	SMD	Outpatient N = 1,057	Inpatient N = 1,057	SMD
Age (mean) range	64 (22–89)	66 (26–93)	0.2	64 (38–89)	64 (31–87)	0.02
Male sex	567 (54%)	2,025 (47%)	0.1	565 (53%)	570 (54%)	0.01
Cohabitation			0.2			0.02
–Cohabitant	880 (83%)	3,290 (76%)		878 (83%)	884 (84%)	
–Alone	179 (17%)	1,035 (24%)		179 (17%)	173 (16%)	
Charlson Comorbidity Index			0.1			0.003
–0 (low)	773 (73%)	2,912 (67%)		771 (73%)	773 (73%)	
–1–2 (medium)	234 (22%)	1,107 (26%)		234 (22%)	232 (22%)	
–≥3 (high)	52 (5%)	306 (7%)		52 (5%)	52 (5%)	
Type of UKA			0.1			0.01
–Medial uncemented	673 (64%)	2,649 (61%)		672 (64%)	674 (64%)	
–Lateral uncemented	2 (<1%)	15 (<1%)		2 (<1%)	1 (<1%)	
–Medial cemented	364 (34%)	1,496 (35%)		363 (34%)	368 (35%)	
–Lateral cemented	20 (2%)	165 (4%)		20 (2%)	14 (1%)	

SMD, standardized mean difference, displayed before and after propensity score matching. SMD > 0.1 indicates imbalance between matching variable. UKA = unicompartmental knee arthroplasty.

Table 2
Outcomes in unmatched and propensity score matched cohorts.

Complications	Pre-Matching			Post-Matching		
	Outpatient N = 1,059	Inpatient N = 4,325	P-value	Outpatient N = 1,057	Inpatient N = 1,057	P-value
Readmissions in 7 days	16 (1.5 %)	61 (1.4 %)	0.8	16 (1.5 %)	12 (1.1 %)	0.4
Readmissions in 30 days	27 (2.6 %)	138 (3.2 %)	0.3	27 (2.6 %)	25 (2.6 %)	0.8
Readmissions in 90 days	45 (4.2 %)	207 (4.8 %)	0.4	45 (4.3 %)	43 (4.1 %)	0.8
90-day mortality	1 (0.09 %)	7 (0.1 %)	0.6	1 (0.09 %)	1 (0.09 %)	1

The Propensity Score Model using ATT (Average treatment effect of the treated) in the matched and unmatched cohort estimates P-values.

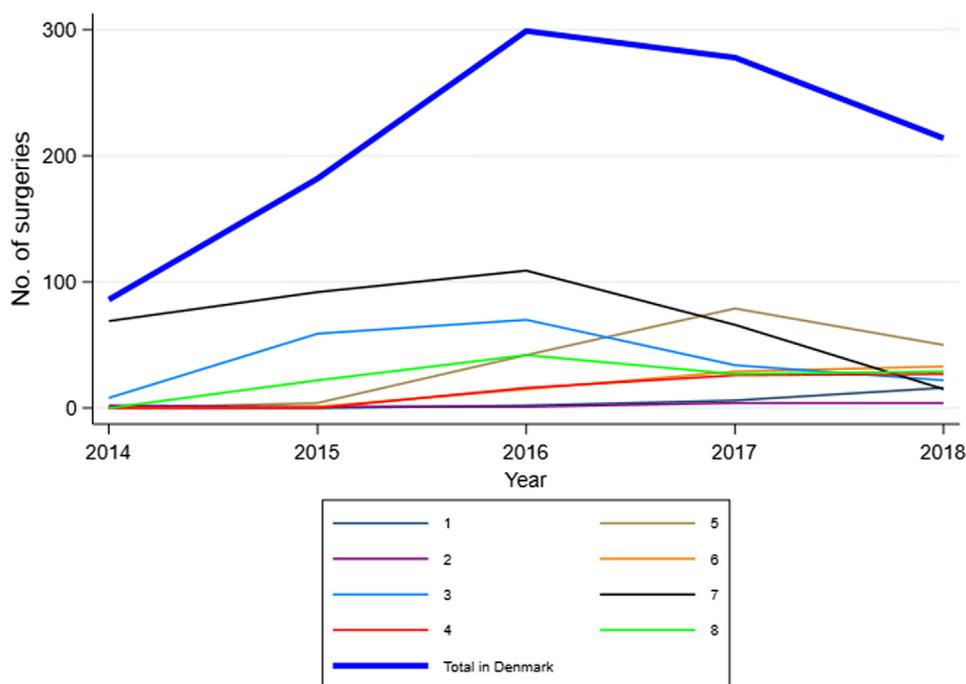


Figure 2. Outpatient surgeries in Denmark in 2014–2018. The figure presents the number of outpatient unicompartmental knee arthroplasty (UKA) surgeries from the eight hospitals in Denmark performing >10 outpatient surgeries in 2014–2018 and the total number of outpatient UKA surgeries performed in Denmark in the same period.

UKA surgeries were performed in 2014 and 214 in 2018 (Figures 2 and 3). Outpatient UKA peaked in 2016 with 299 surgeries.

4. Discussion

Risk of readmission within 7, 30 and 90 days of surgery and 90-day mortality were similar between in- and outpatient UKA performed from 2014 to 2018 for both the matched and unmatched cohorts. An increase in outpatient UKA surgery was observed in the study period.

4.1. Readmission risk and mortality

Our findings support those of previous studies considering readmission risks for both in- and outpatient UKA. They found 30-day readmission risks of 0–4 % and 90-day readmission risks of 2–7 % with no differences between in- and outpatient UKA [19–21]. Our findings of low readmission risks are probably the result of increased use of well-established fast-track programs nationwide. 90-readmission risks of 7–9 % after fast-track TKA has been reported [22,23]. TKA is associated with higher risk of readmission than UKA, but a recent study has found similar risks for surgeries performed at fast-track centers in Denmark [23]. A study considering the safety of outpatient surgery will also be relevant for THA and TKA, for which outpatient surgery can be beneficial as well as for UKA.

Our results were also consistent with previously reported 90-day mortality risks of 0–0.08 % after UKA surgery [20,24].

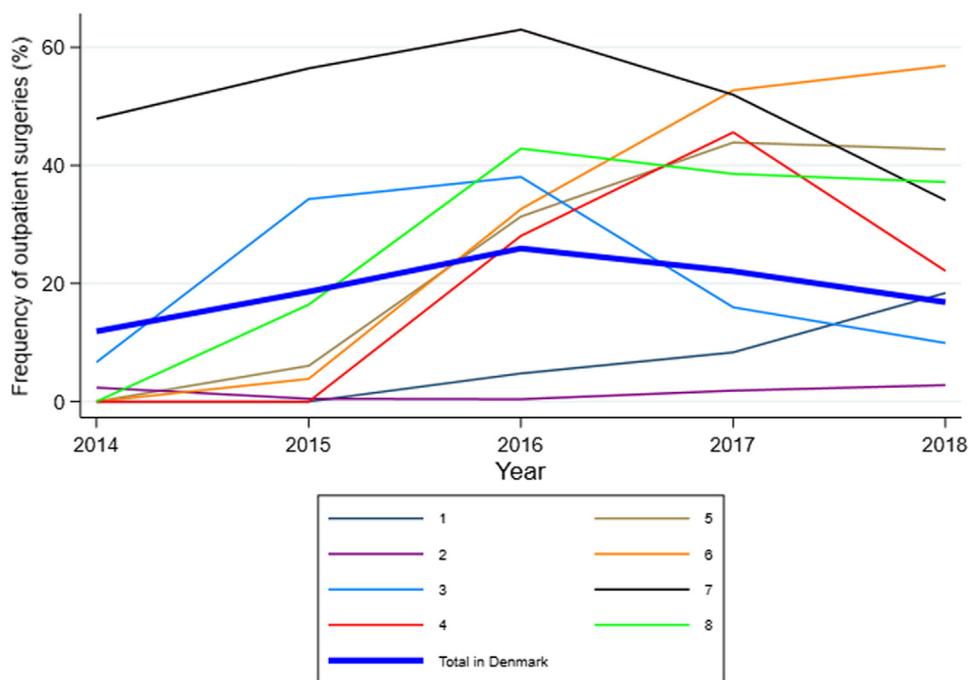


Figure 3. Frequency of outpatient surgeries in Denmark in 2014–2018. The figure presents the frequency of outpatient unicompartmental knee arthroplasty (UKA) surgeries of the total number of UKA surgeries from the eight hospitals in Denmark performing >10 outpatient surgeries in 2014–2018 and the total frequency of outpatient UKA surgeries of the total number of UKA surgeries performed in Denmark.

4.2. Development of outpatient UKA

The amount of outpatient UKA surgeries doubled from 2014 to 2018, with a peak in 2016. Few large volume centers contributed with the majority of outpatient UKA. Most centers increased their proportion of outpatient vs inpatient surgeries in the study period. The variation may be explained by the fact that outpatient programs from each center varies, as outpatient surgery requires a well-established protocol to be feasible [20,25]. However, we did not investigate this aspect in this study as the DNPR does not supply information on the perioperative setup for the individual surgical center.

4.3. Strengths and limitations

A strength of this study is the nationwide coverage with > 99 % completeness of data ensuring a largest study cohort possible for the included procedure codes and complete follow-up [13]. Propensity score matching has limited the bias of important confounders. The selection process of patients eligible for outpatient surgery in the different centers may vary, but no data on this was available in the DNPR. Information on diagnosis codes were collected from the DNPR and were not verified from hospital charts and this is a limitation of our study. However, no obvious differences in registrations of readmissions between in- and outpatient procedures should bias the results of this study.

5. Conclusion

Outpatient medial or lateral UKA seem to be as safe as inpatient UKA on a nationwide basis.

Funding

The study was supported by the Research Council at Lillebaelt Hospital.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.knee.2022.07.008>.

References

- [1] Berg U, Asss WD, Rolfson O, Naclér E, Sundberg M, Nilsson A. Influence of fast-track programs on patient-reported outcomes in total hip and knee replacement (THR/TKR) at Swedish hospitals 2011–2015: an observational study including 51,169 THR and 8,393 TKR operations. *Acta Orthop* 2020;91(3):306–12.
- [2] Büttner M, Mayer AM, Büchler B, Betz U, Drees P, Susanne S. Economic analyses of fast-track total hip and knee arthroplasty: a systematic review. *Eur J Orthop Surg Traumatol* 2020;30(1):67–74.
- [3] Wainwright TW, Memsoudis SG, Kehlet H. Fast-track hip and knee arthroplasty...how fast? *Br J Anaesth* 2021;126(2):348–9.
- [4] Berg U, Bülow E, Sundberg M, Rolfson O. No increase in readmissions or adverse events after implementation of fast-track program in total hip and knee replacement at 8 Swedish hospitals: An observational before-and-after study of 14,148 total joint replacements 2011–2015. *Acta Orthop* 2018;89(5):522–7.
- [5] Berg U, A WD, Nilsson A, Naclér E, Sundberg M, Rolfson O. Fast-Track Programs in Total Hip and Knee Replacement at Swedish Hospitals-Influence on 2-Year Risk of Revision and Mortality. *J Clin Med* 2021;10(8).
- [6] Kehlet H. Fast-track hip and knee arthroplasty. *Lancet* 2013;381(9878):1600–2.
- [7] Liu J et al. Association between same day discharge total knee and total hip arthroplasty and risks of cardiac/pulmonary complications and readmission: a population-based observational study. *BMJ Open* 2019;9(12).
- [8] Nowak LL, Schemitsch EH. Same-day and delayed hospital discharge are associated with worse outcomes following total knee arthroplasty. *Bone Joint J* 2019;101-b(7_Supple_C):70–6.
- [9] Arshi A et al. Outpatient Total Knee Arthroplasty Is Associated with Higher Risk of Perioperative Complications. *J Bone Joint Surg Am* 2017;99(23):1978–86.
- [10] Otero JE, Gholson JJ, Pugely AJ, Gao Y, Bedard NA, Callaghan JJ. Length of Hospitalization After Joint Arthroplasty: Does Early Discharge Affect Complications and Readmission Rates? *J Arthroplasty* 2016;31(12):2714–25.
- [11] Gromov K et al. Complications and readmissions following outpatient total hip and knee arthroplasty: a prospective 2-center study with matched controls. *Acta Orthop* 2019;90(3):281–5.
- [12] Benchimol EI et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. *PLoS Med* 2015;12(10):e1001885.
- [13] Schmidt M, Schmidt SA, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol* 2015;7:449–90.
- [14] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987;40(5):373–83.
- [15] Quan H et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *Am J Epidemiol* 2011;173(6):676–82.
- [16] NOMESCO. NOMESCO Classification of Surgical Procedures (NCSP), version 1.14; 2009. p. 302.
- [17] Austin PC. Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. *Pharm Stat* 2011;10(2):150–61.
- [18] Austin PC. Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. *Stat Med* 2009;28(25):3083–107.
- [19] Boveratwet P, Ondeck NT, Tyagi V, Nelson SJ, Rubin LE, Grauer JN. Outpatient and Inpatient Unicompartmental Knee Arthroplasty Procedures Have Similar Short-Term Complication Profiles. *J Arthroplasty* 2017;32(10):2935–40.
- [20] Gromov K, Petersen PB, Jørgensen CC, Troelsen A, Kehlet H. Unicompartmental knee arthroplasty undertaken using a fast-track protocol. *Bone Joint J* 2020;02-b(9):1167–75.
- [21] Tveit M. On the generalizability of same-day partial knee replacement surgery-A non-selective interventional study evaluating efficacy, patient satisfaction, and safety in a public hospital setting. *PLoS ONE* 2021;16(12):e0260816.
- [22] Jørgensen CC, Kehlet H. Role of patient characteristics for fast-track hip and knee arthroplasty. *Br J Anaesth* 2013;110(6):972–80.
- [23] Jensen CB, Petersen PB, Jørgensen CC, Kehlet H, Troelsen A, Gromov K. Length of Stay and 90-Day Readmission/Complication Rates in Unicompartmental Versus Total Knee Arthroplasty: A Propensity-Score-Matched Study of 10,494 Procedures Performed in a Fast-Track Setup. *J Bone Joint Surg Am* 2021;103(12):1063–71.
- [24] Morris MJ, Molli RG, Berend KR, Lombardi Jr AV. Mortality and perioperative complications after unicompartmental knee arthroplasty. *Knee* 2013;20(3):218–20.
- [25] Vehmeijer SBW, Husted H, Kehlet H. Outpatient total hip and knee arthroplasty. *Acta Orthopaedica* 2018;89(2):141–4.