

## Prospective Evaluation

## Treatment of Osteoporotic Vertebral Compression Fractures: Applicability of Appropriateness Criteria in Clinical Practice

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Disclaimer: Medtronic Spinal & Biologics Europe provided an unrestricted educational grant and was not involved in the design, analysis, interpretation of data, and writing of the manuscript.

Manuscript received:  
03-24-2015  
Accepted for publication:  
07-22-2015

Free full manuscript:  
www.painphysicianjournal.com

**Background:** Appropriate treatment choice for osteoporotic vertebral compression fractures (OVCF) is challenging due to patient heterogeneity. Using the RAND/UCLA method, an international multidisciplinary expert panel established patient-specific criteria for the choice between non-surgical management (NSM), vertebroplasty (VP), and balloon kyphoplasty (BKP).

**Objectives:** To assess the applicability of the appropriateness criteria in real-life practice.

**Study Design:** Prospective observational study.

**Setting:** Eight practices of experts who participated in the panel study, including 2 interventional radiologists, one internal medicine specialist, 2 neurosurgeons, and 3 orthopedic/trauma surgeons. Practices were located in Belgium, Germany, Italy, Switzerland, and the United Kingdom.

**Methods:** Using an online data capture program, participants documented the clinical profile (age, gender, previous VCFs, time since fracture, magnetic resonance imaging (MRI) findings, evolution of symptoms, impact of symptoms on quality of life, spinal deformity, ongoing fracture process, and presence of pulmonary dysfunction) and treatment choice for consecutive patients who consulted them for OVCF.

**Results:** In total 426 patients were included. BKP was the most frequently chosen treatment option (49%), followed by VP (34%) and NSM (14%). When compared with the panel recommendations, inappropriate treatment choices were rare (5% for NSM, 2% for VP, none for BKP). Treatment choice was strongly associated with the clinical variables used in the panel study.

Differences in treatment decisions between interventional radiologists and surgeons were largely determined by differences in patient characteristics, with time of clinical presentation being the dominant factor.

**Limitation:** The study population was restricted to the practices of the participants of the panel study.

**Conclusion:** This international, multi-specialty utilization review showed excellent applicability of, and good adherence with RAND/UCLA-based recommendations on treatment choice in OVCF.

**Key words:** Appropriateness criteria, utilization review, RAND/UCLA Appropriateness Method, balloon kyphoplasty, non-surgical management, osteoporosis, vertebral compression fractures, vertebroplasty

**Pain Physician 2016; 19:E113-E120**

**V**ertebroplasty (VP) and balloon kyphoplasty (BKP) are commonly used for the treatment of osteoporotic vertebral compression fractures (OVCF). Compared to non-surgical management (NSM), predominantly consisting of bed rest, analgesics, and occasionally bracing, these minimally invasive procedures have been shown to provide greater pain relief (1), fewer subsequent fractures (1), increased survival (2), and more favorable cost-effectiveness outcomes (3). Although the evidence from clinical studies is growing, there is still much uncertainty when to choose for NSM, VP, or BKP, which is partly due to the heterogeneity of the patient population. To establish criteria for individualized treatment choice, a RAND/UCLA appropriateness study (4,5) was conducted. Combining the evidence from clinical trials and personal experience from their own practices, a multidisciplinary team of experts assessed the appropriateness of NSM, VP, and BKP for a variety of clinical scenarios. The study produced consistent and specific recommendations: for three-quarters of the scenarios, just one treatment was considered appropriate. In only few situations none of the treatment options was deemed appropriate (6). However, as the outcomes relate to a theoretical population, feasibility of the appropriateness criteria needed to be tested in daily clinical practice. We therefore conducted a prospective observational study that aimed a) to analyze the applicability of the panel criteria and scenarios in a real-life population of patients with OVCF, and b) to study actual treatment decisions in comparison to the panel recommendations.

## METHODS

### Panel Recommendations

The RAND/UCLA panel study into OVCF has previously been described in this journal (6). In summary, a 12-member expert panel from various disciplines (interventional radiology, spine surgery, orthopedic surgery, neurosurgery, trauma surgery, and internal medicine) was asked to assess the appropriateness of NSM, VP, and BKP for 128 clinical scenarios, using a 9-point scale (1 = inappropriate, 5 = uncertain/equivocal, 9 = appropriate). Clinical scenarios were permutations of 7 clinical variables considered relevant to treatment choice: time since fracture, magnetic resonance imaging (MRI) findings, evolution of symptoms, impact of symptoms on quality of life, spinal deformity, ongoing fracture process, and pulmonary dysfunction. The panel process consisted of 2 individual rating rounds and 2 plenary

discussion meetings. Appropriateness of treatment (inappropriate, uncertain, appropriate) was based on the median panel score and agreement between the panelists (5). The panel considerations were limited to patients fulfilling the following criteria: a) OVCF type A, documented with an appropriate imaging technique, b) having at least moderate symptoms (visual analogue score [VAS]  $\geq 5$ ) correlating with the fracture, c) absence of neurological symptoms, d) age  $\geq 18$  years, and e) absence of absolute contra-indications for active treatment (not fit enough to undergo surgery, pregnancy, spine infection, coagulation disorder).

### Study Setting and Population

The study setting consisted primarily of a selection of practices of the experts who participated in the panel study. Selection was based on the availability to contribute to the data collection during the study period. In total 7 panelists and one additional physician participated in the study. These included 2 interventional radiologists, one internal medicine specialist (referral physician), 2 neurosurgeons, and 3 orthopedic/trauma surgeons.

### Data Collection

Participants were asked to document the profiles and treatment choices of all newly seen patients with an OVCF for whom they: a) had to make a treatment choice or b) had to advise on a treatment or c) had received a request for treatment. Data collection took place via an online data capture program (available on both desktop and mobile devices) with a fixed routine (Fig. 1). This started with a check of the inclusion criteria. If positive, the patient profile had to be completed. Only after the treatment choice and reason behind had been documented, the panel recommendations were shown. In the case of a treatment choice that deviated from the panel recommendations, an additional explanation was asked. Deviant was defined as the situation in which the selected treatment was "inappropriate" or "uncertain" according to the panel, while other treatments were deemed more appropriate. Data could not be changed afterwards.

### Analysis

Frequency tables and cross-tabulations were used to describe and analyze the patient characteristics and profiles based on the RAND/UCLA criteria, treatment choices in relation to panel recommendations, and the reasons for deviating from the panel recommendations.

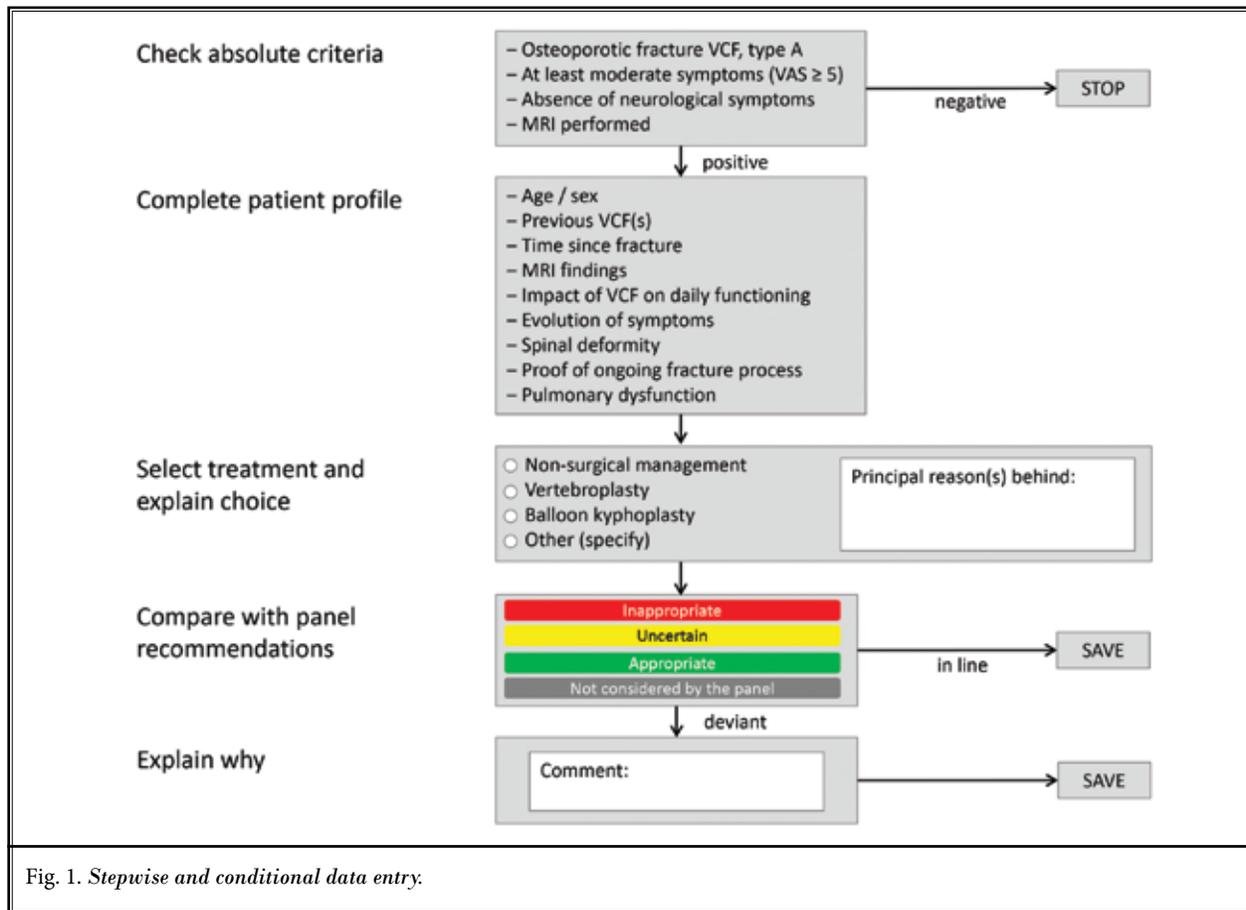


Fig. 1. Stepwise and conditional data entry.

Where applicable, association and correlation measures were used.

### Confidentiality of Data and Protocol Approval

Patient data entered in the system were totally anonymous. Participants had to conform to their national/local Ethics Committee requirements. No additional requirements for data collection were reported.

### Role of the Funding Source

Medtronic Spinal & Biologics Europe provided an unrestricted educational grant and was not involved in the design, analysis, and interpretation of data, nor in writing of the manuscript.

## RESULTS

### Study Population

Data collection took place between April 2013 and August 2014. The 8 physicians (2 interventional radiologists, one internist, 5 surgeons) completed the data for

438 patients. Twelve of them did not meet the inclusion criteria, leaving 426 patients for inclusion in the analysis. The numbers of patients per physician ranged from 9 to 164. The proportions of patients from surgeons and non-surgeons were identical (both N = 213). The majority of patients came from Italy and Germany (44% for each of these countries), the remaining 12% came from the United Kingdom, Belgium, and Switzerland.

### Patient Characteristics by Treatment Choice

BKP was the most frequently chosen treatment option (49%), followed by VP (34%), NSM (14%), and other treatments (predominantly surgical procedures; 2%). Clinical characteristics of patients by treatment choice showed strong and typical relationships (Table 1). In comparison with NSM, both patients with VP and BKP had much higher percentages for almost all unfavorable factors (severe impact on quality of life, progressive factors, spinal deformity;  $P < 0.001$ ). In addition, patients with BKP had these unfavorable condi-

Table 1. Patient characteristics by treatment choice.

	Variables/categories	Treatments (1) (2)		
		NSM %	VP %	BKP %
1.	Gender			
	Male	34	25	23
	Female	65	75	77
2.	Age			
	< 65 years	8	6	20
	65 – 74 years	18	26	26
	≥ 75 years	74	68	54
3.	Previous VCF(s)			
	No	48	73	60
	Yes	52	27	40
4.	Time since fracture			
	< 6 weeks	34	8	35
	6 weeks – 3 months	20	22	53
	> 3 months	46	70	11
5.	MRI findings (3)			
	Negative	31	3	0
	Positive	69	97	100
6.	Impact VCF on daily functioning (4)			
	Moderate	57	26	13
	Severe	43	74	87
7.	Evolution of symptoms (5)			
	Stable	87	55	39
	Has worsened	13	45	61
8.	Spinal deformity (6)			
	No	90	75	39
	Yes	10	25	61
9.	Proof of ongoing fracture process (7)			
	No	97	91	65
	Yes	3	9	35
10.	Pulmonary dysfunction (8)			
	No	92	95	92
	Yes	8	5	8

(1) NSM = Non-surgical management, VP = Vertebroplasty, BKP = Balloon kyphoplasty

(2) Column totals per variable are 100%, but may slightly deviate due to round-offs

(3) Positive MRI: edema visible

(4) Impact of VCF on daily functioning due to mobility impairment and/or pain. It is assumed that pain medication has been optimized.

(5) Evolution of symptoms (mobility impairment, pain) since fracture

(6) ≥ 15% kyphosis and/or ≥ 10% scoliosis and/or ≥ 10% dorsal wall height reduction and/or vertebral body height loss ≥ 20%

(7) Increased height reduction on radiologic images at follow-up (≥ 20% in comparison to initial imaging)

(8) Presence of pulmonary disorders likely to deteriorate due to kyphosis resulting from VCF (e.g., chronic obstructive pulmonary disease)

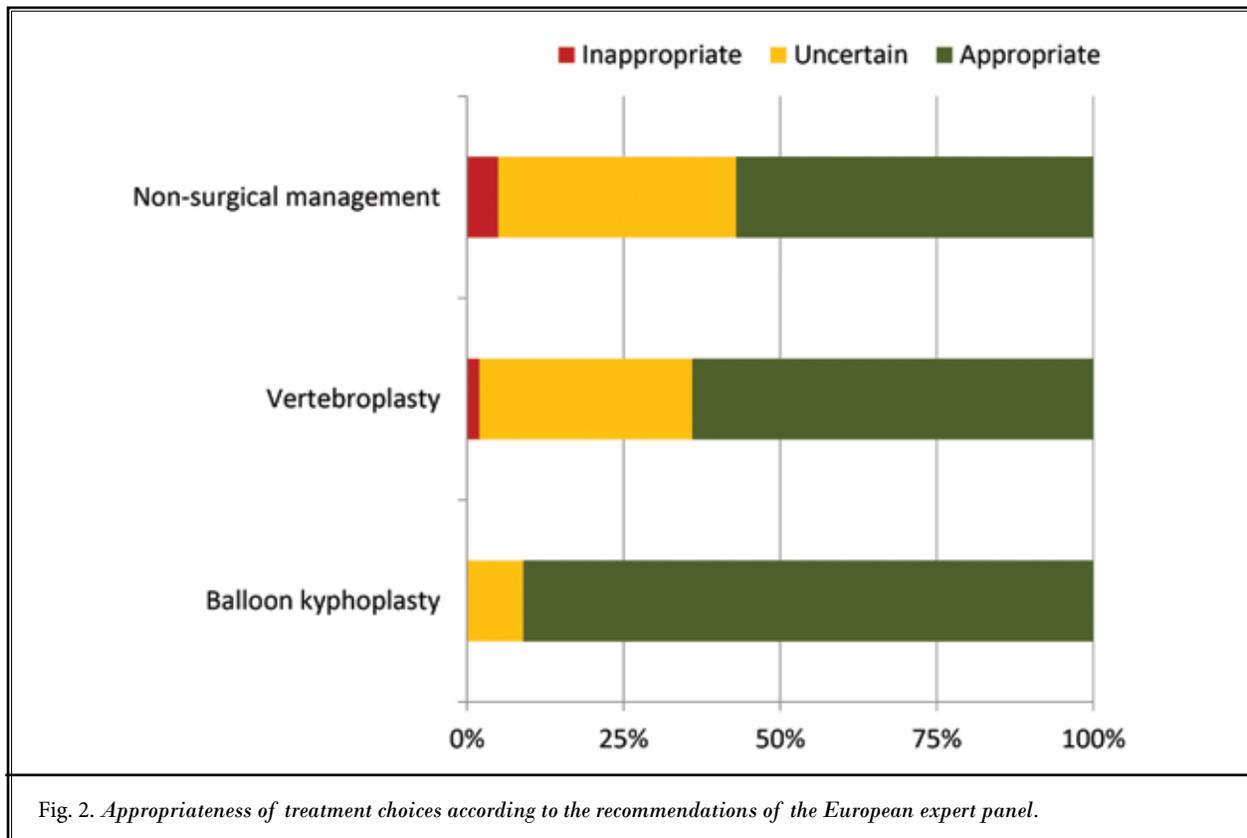
tions more frequently than patients in whom VP was performed: severe impact on daily functioning and progressive symptoms ( $P < 0.01$ ), spinal deformity and ongoing fracture process ( $P < 0.001$ ). A longer time since fracture was much more frequent in VP ( $P < 0.001$ ).

Of the 128 theoretical profiles from the RAND/UCLA panel study, 65 (51%) were seen in the practice population. Maximum frequency of a profile was 36 (9%); 22 profiles covered 80% of patients.

### Appropriateness of Treatment

Fig. 2 shows the appropriateness of treatment choices against the European expert panel recommendations. Inappropriate choices were very rare (5% for NSM, 2% for VP). The choice for BKP was appropriate for the vast majority of cases. The percentages in which the choices were deemed uncertain were comparable for NSM and VP.

For each patient, participants were asked to pro-



vide a short explanation of their treatment choice. Most important reasons for choosing NSM were a negative MRI (23%), poor performance status (20%), symptoms not being severe enough (16%), and patient preference (16%). Both for VP (74%) and BKP (52%) insufficient response to conservative treatment was the dominant reason behind treatment choice. Important other considerations in favor of VP were multiple collapsed fractures (10%), and for BKP the need for anatomical correction (21%) and disease progression (13%).

#### Less Optimal Treatment Choices

In 24% of patients for whom NSM, VP, or BKP was chosen, the treatment could be considered less optimal because a more appropriate alternative had been available. This was true for 43% of NSM cases, 35% of VP cases, and 8% of BKP cases. Table 2 shows the percentages for which alternative treatments would have been a more appropriate choice.

The principal reasons for choosing NSM while other options were more appropriate (open question) included poor performance status (36%) and patient preferences (20%). For VP, the principal reasons behind

“suboptimal” treatment choice were multiple fractures (38%) and old fractures (23%), while for BKP these included higher safety (33%) and advantage of restoring vertebral shape (12%)

#### Differences Between Disciplines

Treatment choice by discipline (5 surgeons versus 3 non-surgeons) varied greatly (Fig. 3). The dominant treatment choice for the surgeons was BKP, and VP for non-surgeons. However, the percentages of appropriate treatment choice were similar for both groups (75% for surgeons and 78% for non-surgeons). Non-surgeons included 2 interventional radiologists and one internist (referral physician). Exclusion of the data of the latter did not significantly change the outcomes for the 2 groups.

The patient population of surgeons differed considerably from that of non-surgeons. In the surgical population, time since fracture was shorter ( $P < 0.001$ ). Furthermore, presence of certain unfavorable factors was higher for patients seen by non-surgeons: severe impact on daily functioning ( $P < 0.001$ ), progressive symptoms ( $P < 0.001$ ), and presence of spinal deformity

Table 2. *Appropriateness of alternative treatments.*

Actual treatment choice (1)	NSM more appropriate %	VP more Appropriate %	BKP more appropriate %
NSM (N = 61)	Not applicable	31	16
VP (N = 146)	6	Not applicable	29
BKP (N = 210)	1	7	Not applicable

(1) NSM = Non-surgical management, VP = Vertebroplasty, BKP = Balloon kyphoplasty

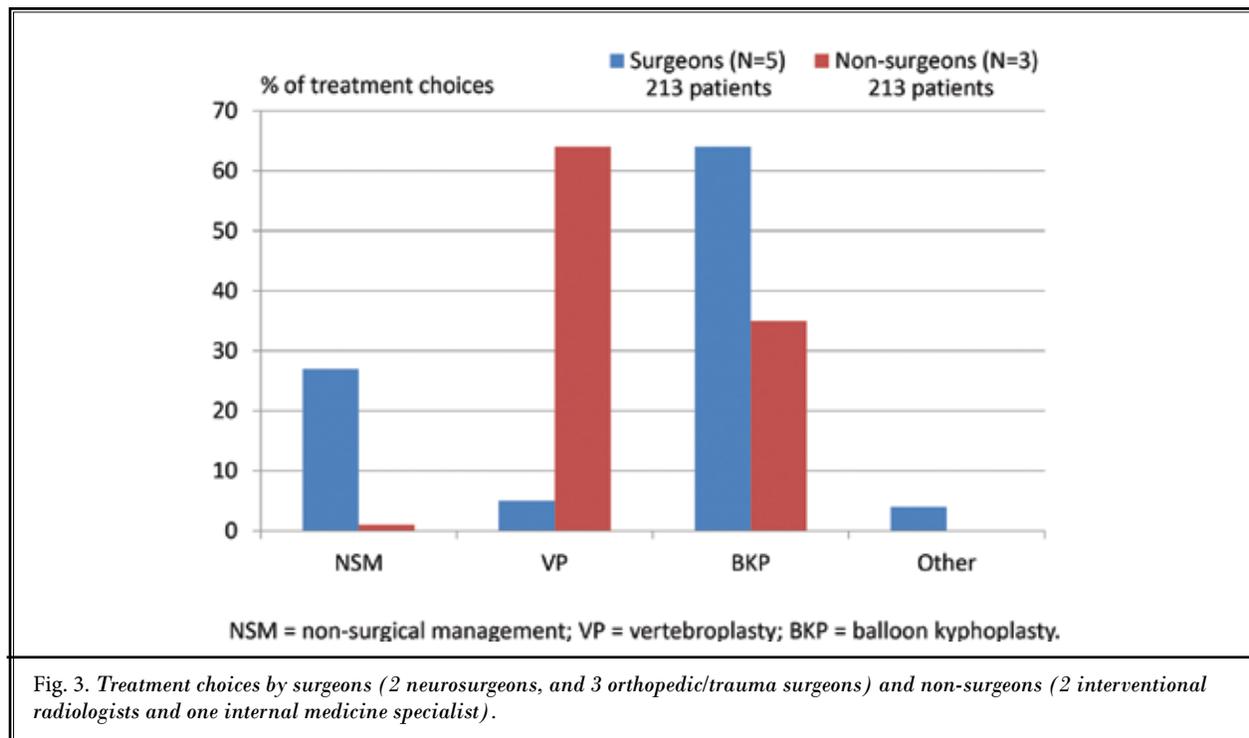


Fig. 3. *Treatment choices by surgeons (2 neurosurgeons, and 3 orthopedic/trauma surgeons) and non-surgeons (2 interventional radiologists and one internal medicine specialist).*

( $P < 0.01$ ). Proof of ongoing fracture process and presence of pulmonary dysfunction did not differ significantly between the groups.

## DISCUSSION

Despite the growing evidence from clinical studies and the availability of many guidelines (3,7-10), personalized treatment choice for patients with OVCF remains challenging. To deal with the heterogeneity of the patient population, a RAND/UCLA appropriateness study was conducted that produced consistent and specific treatment recommendations for 128 different theoretical patient profiles (6). This prospective observational study aimed at determining the feasibility of these recommendations in daily clinical practice.

The strong associations between clinical variables and treatment choice strengthened the appropriateness of the decision model used. Heterogeneity of pa-

tients was confirmed by the fact that around half of the theoretical profiles were actually seen in our population. Twenty-two profiles (17%) covered 80% of patients which is comparable to other RAND/UCLA utilization reviews (11).

In our study population, treatment choices for OVCF were largely in line with the panel recommendations. Differences in treatment choice were predominantly due to case mix, i.e., differences in patient profiles, and the underlying patterns were logical. These differences explained also the variation in treatment choice between non-surgeons (mainly interventional radiologists) and surgeons (orthopedic, trauma, and neurosurgeons), with time of clinical presentation being the dominant factor. A patient with a fresh painful vertebral fracture is usually referred to the emergency room and the first clinical interview is then performed by a surgeon, whereas

a patient with relatively old painful fracture or multiple osteoporotic collapses (in most cases resulting from previous conservative medical treatment) is normally assessed by an internist, rheumatologist, or general practitioner, and subsequently referred to an interventional radiologist. In the first case vertebral height can be corrected by BKP but in older fractures VP should be the treatment choice. Figures on appropriateness of selected treatments were similar for surgeons and non-surgeons.

Although real inappropriate choices were hardly seen in this study population, theoretically better alternatives existed for 24% of treatment decisions. However, the reasons justifying the selection of “suboptimal” treatments were usually logical. For example, the patient’s condition or personal preference largely explained the choice for NSM when VP or BKP were more appropriate alternatives.

The principal limitation of this study relates to the fact that the study population mainly consisted of practices of the physicians who participated in the RAND/UCLA panel study. It could therefore be argued that compliance with the recommendations is more or less a “self-fulfilling prophecy.” However, the results show that consensus-based panel decisions are followed in individual situations in daily clinical practice. The relatively small number of physicians and practices involved may form a second limitation of this study. Finally, participants were all well-educated in the field of VCF treatment, and may not reflect average clinical practice. Larger-scale studies in “non-expert” populations are therefore warranted.

## CONCLUSION

This international, multi-specialty utilization review showed excellent applicability of, and good ad-

herence with RAND/UCLA-based recommendations on treatment choice in OVCF.

## Acknowledgments

### Author Contribution

Rupert Schupfner, Herman Stoevelaar, Thomas Blattert, Daniel Fagan, Patrick Fransen, Stefano Marcia, Frédéric Schils, Mashood Siddiqi, and Giovanni Carlo Anselmetti were involved in the design of the study and/or data collection, contributed to data interpretation, and critically reviewed the manuscript. Herman Stoevelaar performed the statistical analyses. Rupert Schupfner, Giovanni Carlo Anselmetti, and Herman Stoevelaar drafted the manuscript.

### Conflict of Interest

Participants were financially compensated by Medtronic for their time in performing data collection and for attending a panel meeting including reimbursement of related travel expenses. Rupert Schupfner received sponsorship for travel to conferences from Medtronic. Herman Stoevelaar received financial support from Medtronic for the design of the study and analysis of the data. Thomas Blattert is medical consultant to Aesculap, AOSpine, Medtronic, and Spontech, and has received non-financial support from EuroSpine. Daniel Fagan received consultancy fees and travel support from Medtronic. Stefano Marcia is consultant to Vexim and Stryker. Giovanni Carlo Anselmetti, Patrick Fransen, Frédéric Schils, and Mashood Siddiqi have nothing to disclose. Role of the funding source: Medtronic Spinal & Biologics Europe provided an unrestricted educational grant and was not involved in the design, analysis, interpretation of data, and writing of the manuscript.

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