

Orthopedic Practice in Total Hip Arthroplasty and Total Knee Arthroplasty: Results From the Global Orthopaedic Registry (GLORY)

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ABSTRACT

The Global Orthopaedic Registry (GLORY) offers global and country-specific insights into the management of patients undergoing total hip arthroplasty and total knee arthroplasty by drawing on data, from June 2001 to December 2004, of 15,020 patients in 13 countries. GLORY achieved a 70% follow-up rate at 3 and/or 12 months, allowing longer-term findings to be reported.

This paper reports data from GLORY on patient demographics, surgical approaches to patient management, selection of implants, anesthetic and analgesic practices, blood management, length of hospital stay, and patient disposition at discharge. Some aspects of orthopedic practice differ between countries. There was notable variation in the choice and selection of prosthesis, fixation of implants, length of hospital stay, and discharge disposition.

The Global Orthopaedic Registry (GLORY) is an international registry created to examine practices and outcomes in patients who undergo elective total hip arthroplasty (THA) or total knee arthroplasty (TKA). This voluntary registry is physician-directed and came into being by the merger of 2 preexisting registries, the International Orthopaedic Registry (IOR) and The Hip and Knee Registry (THKR), which

was restricted to North America. Results from THKR have been published previously; they highlighted the challenges orthopedic surgeons face when aiming to meet the goal of minimizing hospital stay while ensuring the best long-term outcomes.¹

With the creation of GLORY, it has been possible to gather data on 15,020 patients from 13 countries (see also Anderson² in this supplement for details of the study).

The contemporary literature on orthopedic practice suggests significant variation both between countries and between hospitals. Orthopedic surgeons have a wide and ever-changing choice of implants for use in surgery and are encouraged to adopt best-practice guidelines on many aspects of patient care. Surveys suggest tremendous worldwide variation in both the availability and the cost of different implants for use in THA and TKA.^{3,4} Internationally, there are considerable differences between countries in the use of technologies employed to minimize blood transfusion during orthopedic surgery,⁵ and even within given countries and regions, orthopedic practices can vary greatly according to the preferences and opinions of operating surgeons.^{6,7} For example, while all orthopedic surgeons in the United States appear to agree on the need for prophylaxis against venous thromboembolism (VTE) in patients undergoing THA and TKA, the chosen methods and duration of prophylaxis are highly variable according to individual practices and preferences.⁸

GLORY allows for further study of the similarities and differences in orthopedic practice between countries. This paper reports the registry findings on patient demographics, which highlight parallels and differences between countries in terms of the surgical approaches to patient management, selection of implants, anesthetic and analgesic practices, blood management, length of hospital stay, and patient disposition at discharge. The results presented here are complemented by the GLORY data described in other articles in this supplement, which focus on VTE-prophylaxis patterns⁹ and the functional outcome and complication rates observed following TKA and THA.¹⁰ As with other GLORY data sets, the findings regarding orthopedic practice allow a contrast to be made between prevailing practices in the United States and those adopted in other participating countries. This

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Table I. Demographics of Patients Undergoing Total Hip Arthroplasty

Demographic (%)	Countries		
	All	USA	Others
Patients, n	6,695	3,124	3,571
Median age, years (IQR)	68 (57–75)	69 (58–76)	67 (56–73)
Women	59	55	61
Median BMI, kg/m ² (IQR)	27 (25–31)	28 (25–33)	27 (24–30)
Obese (BMI >30 kg/m ²)	31	38	25
Health problem with ASA grade of severe or worse	27	31	23
Primary diagnosis			
Osteoarthritis	83	86	80
Rheumatoid arthritis	3	2	4
Osteonecrosis	7	6	8
Other	7	7	8
Prior contralateral THA	18	17	19
Location of other disabling joint disease			
None	50	49	51
Contralateral hip	25	21	29
Contralateral knee	8	6	9
Back	16	18	14
Ipsilateral knee	9	8	11
Upper extremity	3	3	4
Foot/ankle	2	2	3
Other	3	3	2
Previous surgery on index joint			
None	91	95	87
Femoral osteotomy	1.0	0.2	1.6
Acetabular femoral fixation	0.2	0.1	0.4
Pelvic osteotomy	0.6	0.1	1.0
Hip arthroplasty	2.3	1.5	3.0
Proximal femoral fixation	1.1	0.8	1.5
Femoral head fixation	0.4	0.3	0.5
Other	4.8	2.5	6.8

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; IQR, interquartile range; THA, total hip arthroplasty.

contrast is valid based upon the number of participating countries and centers. However, data from individual countries other than the United States may sometimes be more reflective of center practice, because there were relatively few centers in some countries.

METHODS

The methodology of data collection for GLORY is described in detail in the opening article in this supplement.² The registry enrolled 15,020 patients from 100 hospitals in 13 countries (Australia, Brazil, Bulgaria, Canada, Colombia, Germany, Italy, Japan, Poland, Spain, Turkey, United Kingdom, United States) during the period June 2001 to December 2004. Patients eligible for GLORY were those undergoing THA or TKA for whom a 12-month clinical follow-up period was feasible. GLORY had a 70% combined 3-month and/or 12-month follow-up rate.

Data concerning patient demographics, primary diagnosis, preexisting comorbid conditions, surgical approach, implant selection, blood management, type of anesthesia, VTE prophylaxis, length of hospital stay, and discharge disposition were gathered using standard case report forms (CRFs). Where appropriate, chi-square or Fisher's exact tests were used to test for rate differences in different groups. Wilcoxon's rank sum test was used to test differences between continuous variables, by group.

RESULTS

Total Hip Arthroplasty

Demographic Data on Total Hip Arthroplasty. Data were provided on 6,695 THA procedures by 86 of the 100 participating hospitals (Table I). The median age of patients undergoing this procedure in the United States was 69 years, and for other participating countries was 67 years. More women than men underwent THA in both the United States and other countries (55% and 61% of patients were women, respectively). The median body mass index (BMI) of THA patients was similar in the United States (28 kg/m²) and other countries (27 kg/m²), although more patients from the United States had a BMI > 30 kg/m² (38%) compared with other countries (25%).

In terms of coexisting chronic health problems, 31% of US patients, as compared with 23% of patients from other countries, had severe or worse chronic health problems of moderate to significant severity (ASA [American Society of Anesthesiologists] Grade III or above). As expected in these orthopedic patients, a high proportion (86% of patients in the United States and 80% in other countries) suffered from osteoarthritis. A smaller proportion of THA patients (2% in the United States and 4% in other countries) had rheumatoid (inflammatory) arthritis or were diagnosed with osteonecrosis (6% of patients in the United States and 8% in other countries) (Table I).

Table II. Procedure Used for Total Hip Arthroplasty

Procedure, %	Countries		
	All	USA	Others
Surgical approach			
Posterior	55	73	43
Trochanteric	11	5	15
Anterior lateral	33	22	41
Duration of surgery <2 hours	81	77	82
Anesthesia*			
General	51	58	45
Spinal	41	33	47
Epidural	14	18	11
Lumbar plexus block	2	0.1	4
Continuous epidural analgesia	16	22	12
VTE prophylaxis			
Any in-hospital	99.5	99	99.6
Any post-discharge	29	44	19
Antibiotics			
Single dose	9	0.5	16
≤24 hours	44	54	35
>24 hours	47	45	48
Heterotopic ossification prophylaxis			
None	82	96	74
Radiation	1	2	0.2
Indomethacin	17	2	26

*Patients could receive more than one type of anesthetic.
Abbreviations: VTE, venous thromboembolism.

Of patients enrolled in GLORY, 18% had undergone a prior contralateral THA. Half the patients had significant arthritic problems in other joints that were considered likely to influence the outcome of THA; 25% presented with contralateral hip arthritis, 9% with ipsilateral knee arthritis, and 8% with contralateral knee arthritis. Ninety-five percent of US patients had not had a previous operation to the joint, 0.2% had undergone a previous femoral osteotomy, 0.1% a previous pelvic osteotomy, 0.8% a proximal femoral fixation, and 1.5% a unipolar or bipolar arthroplasty for fracture. Patients from the UK GLORY centers had only a 2% incidence of previous surgery, while in the Australian center, 66% of patients had undergone previous hip surgery.

The basic demographic findings of THA patients in GLORY reflect the reports of other orthopedic registries and large-scale studies in orthopedic patients. Candidates for THA are more likely to be women between 65 and 70 years of age with a history of osteoarthritis without previous orthopedic surgery.¹¹⁻¹⁶

Procedure Used for Total Hip Arthroplasty. Total population data from GLORY show that 55% of procedures were performed using a posterior approach, 33% using an anterior lateral approach, and 11% using a trochanteric approach (Table II). Results reveal substantial variation in surgical approach by country. In the United States, 73% of patients were operated upon via a posterior approach. There was no association between the type of approach and dislocation rate in the United States, yet a significant association was seen ($P = .002$) in other participating countries; the highest dislocation rates were noted for THA using a posterior approach (2.1%), followed by a 1.6% dislocation

rate using a trochanteric approach, and only 0.5% using an anterior lateral approach.

Most procedures (81%) were completed within 2 hours. Length of surgery was not significantly associated with the rates of in-hospital or post-discharge complications in the United States, although in other participating countries, an association was noted between length of surgery and both dislocation rates ($P = .04$) and fracture rates ($P = .002$). Indeed, when duration of surgery extended beyond 2 hours, dislocation rates and fracture rates were higher compared with rates for surgery of 2 hours or less: 2.3% versus 1.1% dislocation and 2.5% versus 0.8% fracture, respectively.

General anesthesia was the preferred choice of anesthesia—being used in 51% of THA patients in GLORY—followed by spinal anesthesia (41% of cases) and epidural anesthesia (14% of cases). Combined forms of anesthesia were employed for some patients (Table II). Continuous epidural catheter delivery of analgesia was used in 16% of THA patients; in most of these cases (97%), this pain relief was discontinued after the second postoperative day.

Blood salvage is a technique where blood lost by the patient during the surgery is collected and transfused back into the patient either intraoperatively or postoperatively. In GLORY, only 18% of THA patients were managed using blood-salvage techniques, of which approximately one half received intraoperative blood salvage (Table III). A quarter (25%) of THA patients received autologous blood postoperatively at a median volume of 600 mL, and 57% of patients required 1 or more unit of blood (median volume, 600 mL) following surgery (Table III).

As described in detail by Friedman and colleagues,^{9,17} 99.5% of GLORY patients undergoing THA were given in-hospital VTE prophylaxis. Prophylaxis was continued after discharge in only 29% of patients (Table II). Antibiotic therapy was given for > 24 hours to 47% of patients, whereas 44% of subjects received antibiotics for ≤ 24 hours and 9% received a single dose after THA. Only 18% of all patients were given specific therapy for the prevention of heterotopic ossification, although this practice was common in the German center. Indomethacin was the treatment of choice for prophylaxis against ossification.

Table III. Blood Usage in Total Hip Arthroplasty Patients

	Countries		
	All	USA	Others
Preoperative autologous blood management, %	25	42	15
Blood salvage, n	4,459	1,657	2,802
Total, %	18	22	15
Intraoperative, %	1	2	1
Postoperative, %	9	6	10
Both, %	8	15	4
Blood transfusion*, n	5,149	1,778	3,371
Total, %	57	55	58
Autologous, %	25	38	18
Donor, %	36	21	44

*Patients could receive more than 1 type of transfusion.

Table IV. Selection of Total Hip Arthroplasty Implants

Implant	Countries		
	All	USA	Others
Patients, n	6,695	3,124	3,571
Acetabular component			
Fixation, %			
Cemented	18	5	29
Porous	55	76	38
Hydroxyapatite	18	12	23
Other	8	6	9
Bearing surface			
Standard polyethylene	36	28	42
Highly cross-linked polyethylene	55	63	49
Metal	5	5	5
Ceramic	4	3	4
Other	0.2	0.1	0.3
Femoral component			
Fixation (stem)			
Cemented	41	30	50
Porous	41	55	29
Hydroxyapatite	16	14	18
Other	2	1	3
Head material			
Steel	19	4	32
Chrome	57	82	36
Titanium	9	7	10
Ceramic	12	5	18
Other	3	1	4

Table V. Length of Hospital Stay and Discharge Disposition After Total Hip Arthroplasty

Country	Patients, n	Median Length of Hospital Stay, Days (IQR)	Discharge, %	
			Home	Rehab. Center /Other
All	6,695	5 (3–11)	64	36
Australia	204	6 (5–8)	63	37
Brazil	221	7 (6–7)	97	3
Bulgaria	68	19 (16–23)	97	3
Canada	514	5 (4–6)	31	69
Colombia	191	4 (3–5)	98	2
Germany	456	11 (9–13)	70	30
Italy	628	10 (9–12)	88	12
Japan	68	30 (29–32)	19	81
Poland	690	16 (14–21)	94	6
Spain	236	12 (9–14)	100	0
Turkey	81	11 (8–16)	100	0
UK	214	9 (8–10)	97	3
USA	3,124	3 (3–4)	47	53

Abbreviations: IQR, interquartile range.

Implant Selection for Total Hip Arthroplasty. Analyses of all data from GLORY showed that 18% of THA patients received a cemented acetabular component, 55% received an uncemented component (uncemented metal shell with polyethylene liner), and 18% received a hydroxyapatite-coated metal shell with a polyethylene liner (Table IV). Choice of polyethylene was varied. In 36% of patients undergoing THA, standard polyethylene was used, but in 55% highly cross-linked polyethylene was employed. In the United States highly cross-linked polyethylene was used more often than standard polyethylene (63% and 28%, respectively), while these types of polyethylene were used more evenly in other participating countries (49% and 42%, respectively). Overall, 5% of THAs were metal on metal and 4% were ceramic on ceramic.

Geographic differences were also seen in cementing practices, with only 5% of US cups being cemented, compared with 29% of cups in other participating countries. In the United States, porous cups were used most frequently (76%); in the other participating countries, porous cups were used in 38% of THA patients.

Overall, there was equal division between cemented (41%) and porous (41%) in-growth femoral components, and there was a 16% use of hydroxyapatite-coated components (Table IV). Cemented femoral stems were used more often in participating centers outside of the United States (50%) than in the US centers (30%).

One of the most important concerns following THA is the durability of joint replacements. The available long-term evidence suggests excellent clinical success rates and high 15- to 20-year survivorship of femoral and acetabular components, whether cemented or fixed by cementless

means.^{18,19} However, there are recognized advantages and disadvantages to both cemented and cementless fixation.^{20,21} Increasingly, cementless acetabular socket fixation is viewed as best practice for THA, with cemented fixation becoming almost obsolete.²²⁻²⁴ The GLORY data appear to reflect this trend away from widespread reliance on cemented acetabular components.

The use of cementless femoral fixation is more controversial than cementless acetabular fixation. Indeed, closer scrutiny of the literature reveals that some follow-up and survival studies appear to favor cementless femoral components,^{11,25,26} some advocate cemented femoral fixation,²⁷ while others report no clear differences between the 2 forms of fixation.^{28,29} Differences in surgical technique, prosthesis design, and factors such as differing patient characteristics and follow-up time between studies could have contributed to these conflicting reports. In general, the GLORY data show low usage of cemented femoral components, although cement is still used more often in femoral fixation than in acetabular fixation. Of note, the practice of cementless fixation in THA was more common in the United States than in other participating countries.

Concerns have arisen about the wear of polyethylene in cementless prosthetic components, which is thought to lead to osteolysis and loosening of the implant and appears to particularly affect acetabular components.^{30,31} Increased wear of acetabular cementless cups has been reported in a 15-year follow-up study comparing cemented and cementless cup fixation,²³ and this has been corroborated by other studies.^{11,32}

Postoperative Management of Total Hip Arthroplasty Patients. Following THA, 64% of GLORY patients were discharged from hospital to their home, while 36% were discharged to a rehabilitation or other facility (Table V). Physical therapy was provided to 73% of patients after their discharge from the acute hospital setting.

Table VI. Demographics of Patients Undergoing Total Knee Arthroplasty

Demographic, %	Countries		
	All	USA	Others
Patients, n	8,325	5,209	3,116
Median age, years (IQR)	70 (62–76)	69 (61–76)	71 (65–76)
Women	66	62	72
Median BMI, kg/m ² (IQR)	30 (27–35)	31 (27–36)	29 (26–33)
Obese (BMI >30 kg/m ²)	50	56	42
ASA grade severe or worse	32	37	24
Primary diagnosis			
Osteoarthritis	94	95	91
Rheumatoid arthritis	3	2	5
Osteonecrosis	0.5	0.5	0.5
Other	3	2	3
Prior contralateral TKA	20	19	21
Location of other disabling joint disease			
None	46	48	42
Contralateral knee	36	32	42
Contralateral hip	4	3	7
Back	12	11	13
Ipsilateral hip	4	3	6
Upper extremity	4	3	6
Foot/ankle	3	3	4
Other	3	4	3
Previous surgery on index joint			
None	70	69	73
Patellectomy	0.3	0.3	0.1
High tibial osteotomy	1.5	0.9	2.5
Distal femoral osteotomy	0.1	0.1	0.1
ORIF femur	0.4	0.5	0.1
ORIF tibia	0.5	0.6	0.5
Open meniscectomy	7	8	4
Arthroscopy	10	10	9
Ligament reconstruction	1	1	0.6
Patellofemoral alignment	0.4	0.4	0.3
Other	8	6	13
Alignment			
Normal	18	16	21
Varus deformity	62	60	65
Valgus deformity	20	24	14

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; IQR, interquartile range; ORIF, open reduction with internal fixation; TKA, total knee arthroplasty.

Once again, patterns of postoperative management showed marked geographic variation. While 97% of patients from the participating UK centers (with a median hospital stay of 9 days) and 98% of Colombian patients were discharged home (median hospital stay of 4 days), only 47% of patients in the United States (median stay of 3 days) and 31% of Canadian patients (median stay of 5 days) went back to their own home. There was an overall trend toward increased length of acute hospital stay in those jurisdictions where patients were not routinely discharged to rehabilitation or where post-acute hospital-based rehabilitation could not be offered. Thus, the median hospital stay for THA patients in GLORY was 7 days for those discharged to home and was 4 days for those discharged to rehabilitation or some other facility. The differences in length of stay should, however, be treated with caution, as differences in the percentage of patients discharged to rehabilitation facilities, where the care is essentially equivalent to the hospital, may have an effect on the mean hospital length of stay.

Table VII. Procedure Used for Total Knee Arthroplasty

Procedure, %	Countries		
	All	USA	Others
Surgical approach			
Anteromedial	88	87	91
Anterolateral	1	1	1
Subvastus	6	7	4
Other	5	5	4
Duration of surgery <2 hours	86	88	85
Anesthesia*			
General	43	43	42
Spinal	46	43	52
Epidural	20	25	12
Lumbar plexus block	1	0.02	2
Anterior continuous catheter	0.2	0	0.6
Femoral nerve block	5	5	4
Continuous epidural analgesia	25	31	17
VTE prophylaxis			
Any in-hospital	99	99	99
Any post-discharge	36	45	23
Antibiotics			
Single dose	10	0.6	26
≤24 hours	44	49	35
>24 hours	46	51	39

*Patients could receive more than 1 type of anesthetic.
Abbreviations: VTE, venous thromboembolism.

At the time of discharge from hospital, 93% of patients had no documented complication. In-hospital mortality was recorded at just 0.1%, showing an extremely low death rate associated with THA, and the most common cause of postoperative death was a cardiac-related event. The GLORY in-hospital mortality rate was less than that reported in the Norwegian Arthroplasty Registry, for which postoperative mortality at day 20 was 0.4%, at day 60 was 0.8% and at day 90 was 0.9%, with most deaths being attributed to vascular causes.³³ A full account of the complications and functional outcomes following THA and TKA in GLORY is given in this supplement in the article by Cushner and colleagues.¹⁰

Total Knee Arthroplasty

Demographic Data on Total Knee Arthroplasty. As shown in Table VI, data were collected on 8,325 patients undergoing TKA at 96 of the 100 hospitals from the 13 countries participating in GLORY. The median age of patients undergoing TKA was 69 years in the United States and 71 years in other participating countries. As with THA, a higher percentage of women underwent TKA than men in both the United States (62%) and other countries (72%). Patients had a median BMI of 31 kg/m² in the United States and 29 kg/m² in other countries, and again, the proportion of patients with a BMI > 30 kg/m² was higher in the United States (56%) than in other countries (42%). Health problems of severe or worse severity (ASA Grades III and above) were noted among 37% of US patients and 24% of patients from other countries. There was a 95% rate of osteoarthritis in the United States and 91% rate in other countries, with a 2% (United States) and 5% (other countries) incidence of rheumatoid arthritis and an overall 0.5% rate of osteonecrosis among TKA patients.

Table VIII. Blood Management in Total Knee Arthroplasty

	Countries		
	All	USA	Others
Median duration of tourniquet use, min (IQR)	71 (60–90)	69 (57–85)	75 (60–90)
Preoperative autologous blood management, %	21	27	13
Blood salvage, n	5,221	2,765	2,456
Total, %	31	41	19
Intraoperative, %	0.7	0.7	0.7
Postoperative, %	19	25	13
Both, %	11	16	6
Blood transfusion*, n	6,073	3,073	3,000
Total, %	42	38	46
Autologous, %	24	28	20
Donor, %	20	12	29

*Patients could receive more than 1 type of transfusion.

Nineteen percent of US patients and 21% of patients from other countries had a prior contralateral TKA. Over half of US patients (52%) and patients from other countries (58%) had significant arthritic problems in other joints that could be expected to influence the outcome of their TKA. In particular, among US patients, 32% had contralateral knee arthritis, 3% had ipsilateral hip arthritis, and 3% had contralateral hip arthritis. In the entire GLORY cohort, 70% of patients had no history of previous surgery on the index joint. The most frequent forms of prior intervention were arthroscopy (10%), open meniscectomy (7%), and ligament reconstruction (1%). However, rates varied greatly according to country, with 96% of patients from the Australian center having a history of prior procedures to the knee, but only 9% of patients from the Japanese center having undergone prior knee surgery before the index TKA. It was noted that 62% of patients had a documented varus deformity, 20% had a valgus deformity, and 18% had neutral or insignificant varus/valgus alignment prior to surgery.

In GLORY, TKA patients were more likely to be women, were of age 65 to 75 years, typically had a history of osteoarthritis, and tended not to have undergone previous orthopedic surgery. These basic demographic findings reflect the reports of other orthopedic registries and large-scale studies in orthopedic patients.^{15,34}

Procedure Used for Total Knee Arthroplasty. The anteromedial approach was most commonly taken for TKA procedures in the GLORY population, being used in 88% of cases (Table VII). By contrast, just 6% of surgery was performed through a subvastus approach; most of these procedures were in the United States (7% were performed using a subvastus approach) and in the center in Germany (18% were performed using a subvastus approach). On balance, a subvastus approach allowed quicker surgery (93% of subvastus surgery was performed within 2 hours) than anteromedial and anterolateral approaches (86% and 80% of these cases were complete within 2 hours; $P < .01$ for any

Table IX. Total Knee Arthroplasty Implant Selection*

Implant	Countries		
	All	USA	Others
Patients, n	8,325	5,209	3,116
Prosthesis fixation			
Cemented	90	91	89
Porous	9	8	10
Hydroxyapatite	0.8	1	0.6
Other	0.1	0.1	0.1
Tibial component			
Cemented	95	95	94
Porous	5	4	6
Hydroxyapatite	0.3	0.2	0.5
Other	0.1	0.1	0
Patellar component			
Not resurfaced	28	7	63
Cemented	70	91	36
Cementless	1	2	1
Prosthetic type			
Retained	45	44	46
Substitute	49	54	41
Constrained PCL	5	2	11
Meniscal bearing	3	1	5
Rotating hinge	1	0.4	3
Tibial component material			
All polyethylene	10	6	16
Metal-backed	85	94	70
Cross-linked polyethylene	30	15	55
Ceramic	0.01	0.02	0
Tibial polyethylene thickness > 8 mm	14	12	16
Patellar component material			
All polyethylene	81	89	50
Metal backed	9	9	12
Cross-linked polyethylene	19	9	57
Ceramic	0.07	0.04	0.2

*Patients could have more than 1 type of prosthetic, tibial component, and patellar component.

Abbreviations: PCL, posterior cruciate ligament.

rate difference). Length of surgery was found to have a significant association with the rate of fracture ($P = 0.03$). When surgery lasted ≥ 2 hours, the fracture rate was 0.9% compared with 0.2% for surgery lasting < 2 hours. This association was not found to be significant when data for the United States alone or for other participating countries alone were evaluated, and no other associations were found between length of surgery and any in-hospital or post-discharge complication.

With regards to anesthetic and analgesic practices for TKA, 43% of patients had general anesthesia, 46% received spinal anesthesia, and 20% had an epidural. Some patients had combination anesthesia (Table VII). A continuous epidural catheter for analgesia was used in 25% of patients.

Overall, 31% of patients were managed with blood salvage, and this generally occurred postoperatively (62% of salvage patients) (Table VIII). Blood salvage was most commonly used in the United States (41%) and in centers in the United Kingdom (45%) and Italy (44%). Preoperative blood transfusion (autologous; median volume of 395 mL) was used in 21% of TKA patients, and 42% of all patients received 1 or more unit of blood after surgery.

Table X. Length of Hospital Stay and Discharge Disposition After Total Knee Arthroplasty

Country	Patients, n	Median Length of Hospital Stay, Days (IQR)	Discharge, %	
			Home	Rehab. Center /Other
All	8,325	4 (3–9)	58	42
Australia	238	6 (5–7)	73	27
Brazil	26	7 (6–7)	96	4
Bulgaria	6	21 (20–25)	100	0
Canada	342	5 (4–6)	31	69
Colombia	111	4 (3–6)	99	1
Germany	615	12 (9–15)	69	31
Italy	864	10 (9–12)	71	28
Japan	22	21 (19–23)	100	0
Poland	327	16 (14–20)	93	7
Spain	229	11 (9–13)	99	0.4
Turkey	127	12 (10–15)	98	2
UK	209	9 (8–10)	94	6
USA	5,209	3 (3–4)	48	52

Abbreviations: IQR, interquartile range

Use of VTE prophylaxis in TKA patients was high. In hospital, 99% of TKA patients were given some form of VTE prophylaxis, but only 36% of patients continued to receive prophylaxis after discharge (Table VII). A more comprehensive account of VTE-prophylaxis practices has been reported elsewhere.^{9,17} In TKA patients, the regimen of antibiotic treatment for prophylaxis against infection was > 24 hours in 46% of patients, ≤ 24 hours in 44% of patients, and a single dose in 10% of patients (Table VII).

Tourniquet Use During Total Knee Arthroplasty. Use of an intraoperative tourniquet during TKA is widespread, although variations in frequency of use, duration of application, and timing of release have been reported in the literature. A tourniquet is thought to reduce blood loss by helping to maintain a bloodless field. Debate surrounds the issue of whether a tourniquet should be released during surgery and after cementing, or after completion of the entire surgical intervention.^{35–37} In GLORY the median duration of tourniquet use was 71 minutes for the entire population (Table VIII), although geographic differences were evident, with patients in Italian GLORY centers having a tourniquet in place for a median of 60 minutes as compared with 95 minutes in Colombia.

Implant Selection in Total Knee Arthroplasty. In most countries participating in GLORY, 99% to 100% of TKA patients received a cemented prosthesis (Table IX). Geographic variation in practice was evident in the management of the patellar component. Whereas over 90% of patients in the United States had cemented patellar components, only 36% of patients in other participating countries had a cemented patellar component.

Most (85%) tibial components were metal-backed, while patellar components were all-polyethylene in 81% of cases. Median tibial polyethylene thickness was 1 mm; in 14% of cases the thickness was > 8 mm.

The GLORY population reveals a fairly even distribution of cruciate-retaining versus cruciate-sacrificing implants. In 45% of TKAs in GLORY, a posterior-cruciate-ligament-retaining prosthesis was used, whereas in 49% of cases, a substituting prosthesis was used. Only 3% of TKAs used a meniscal-bearing prosthesis and 1% a rotating hinge, with these cases most likely in patients with significant preoperative instability. As in THA, there is a wide and ever-increasing choice of devices available to surgeons performing TKA, yet a study conducted in the United Kingdom suggests that clinical evidence is often lacking to support implant choice. More than half (54%) of the implant devices available in the UK orthopedic market for TKA were found to have no peer-reviewed evidence to support their use; this highlights the difficulties surgeons face when deciding which implant is best suited to a patient's immediate and long-term orthopedic needs.³⁸

Although cementless fixation is widely used in THA, it is used less commonly in TKA. Some studies suggest a good or similar outcome at 5 to 10 years for cementless TKA compared with a cemented prosthesis,^{39,40} whereas others suggest higher loosening and revision rates with cementless fixation^{41,42} and particularly with metal, tibial, and patellar components.^{43,44} The age of the patient and physical activity may impact implant selection and also the choice of technique for fixation in TKA. Cementless TKA has been reported to be reliable in younger (< 50 years of age) and physically active patients.⁴⁵ In this group of patients, the use of mobile-bearing knees, which are thought to reduce wear, has been shown to yield good clinical results and high rates of prosthesis survival.^{46–48}

Postoperative Management of Total Knee Arthroplasty Patients. GLORY patients undergoing TKA were discharged to their home after surgery in 58% of cases and to a rehabilitation or other facility in 42% of cases (Table X). The majority of patients (88%) received a form of physical therapy after discharge from the acute care setting. Geographic variations were apparent in the postoperative management of TKA patients. In participating centers in the United Kingdom, 94% of patients were discharged home (with a median hospital stay of 9 days), whereas in Colombia centers, 99% went home (median stay of 4 days). In the United States, 48% of patients were discharged home (median stay of 3 days), and in Canada, 31% of patients went home (median stay of 5 days).

As with THA, when patients could not be sent to rehabilitation facilities or offered post-acute rehabilitation at home, length of stay in hospital was longer. The median stay for patients discharged home was 5 days and for those sent to rehabilitation was 4 days. In-hospital mortality after TKA was 0.1%, showing an extremely low death rate associated with TKA, and the most common cause of death was a cardiac event. The majority of TKA patients (92%) were discharged without a documented complication (see also Cushner and colleagues¹⁰).

Differences Between Total Hip Arthroplasty and Total Knee Arthroplasty Practices

In many regards, the demographics and the management of THA and TKA patients run in parallel. However, GLORY shows that TKA patients are typically older than THA patients, have a higher BMI, and have a poorer health status (all $P < .001$). TKA patients were also more likely to undergo surgery taking less than 2 hours ($P < .001$), have had previous surgery on the same joint ($P < .001$), and have had prior contralateral surgery ($P = .0004$) than THA patients. During orthopedic procedures, more patients undergoing TKA, compared with patients undergoing THA, received continuous epidural analgesia ($P < .001$), and cementing of implants appeared to be more common in TKA than in THA.

CONCLUSIONS

This review of international orthopedic practice based on data from GLORY demonstrates many similarities in the type of patients and in the general intraoperative and postoperative approaches used to care for patients who have undergone THA and TKA. Many aspects of orthopedic practice differ from country to country. There is notable variation in the choice and selection of prostheses, fixation of implants, length of hospital stay, and discharge disposition. Although there were relatively few centers in some countries, the differences in practice highlighted by GLORY are important.

GLORY shows that, in most countries, THA surgery is performed through a posterior or anterior lateral approach, with surgery typically falling within 2 hours. Cementless fixation in THA is common. The practice for TKA is to perform prosthesis placement through an anteromedial approach, and GLORY suggests a predominance of cemented fixation. As with THA, surgery typically lasted under 2 hours. Functional outcomes are discussed by Cushner and colleagues.¹⁰

Although prophylaxis for heterotopic ossification is not widely practiced after THA, the use of antibiotics and VTE prophylaxis is standard in patients undergoing either THA or TKA. This latter observation may, however, be skewed by the voluntary nature of the registry and does not take into account the appropriateness of prophylaxis measures taken. Patients are typically discharged to home after their acute hospital stay, and there is a universal emphasis on providing post-discharge physical therapy following both THA and TKA.

GLORY provides a unique source of information on patient demographics and patterns and practices in THA and TKA orthopedic care. By documenting variations in choice of implant, nuances in surgical technique, and differences in preoperative, perioperative, and postoperative approaches to patient care, it may be possible to identify factors that have important effects on the clinical and functional outcome following major orthopedic surgery.

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