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Orthopedic Network News

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2020 Hip and Knee Implant Review

The number of US hip and knee implant procedures performed in the United States increased between 2018 and 2019 by 4.2% to 1,728,300 according estimates from iData Research, Inc. of Vancouver, British Columbia. The number of hip replacement procedures grew 3.4% to 669,100 in 2019, and knee replacements grew 4.7% to 1,059,200. The fastest growing segments were revision knee procedures (up 6.1% over 2018) and primary knees (up 4.8% to 884,000). Revision knees again outnumbered revision hips in 2019.

Orthopedic Network News is reporting both the inpatient and outpatient Medicare volumes in calculating the top 10 joint replacement hospitals. Inpatient cases assigned to MS-DRGs associated with joint replacements were added to the Medicare outpatient cases assigned to the CPT codes for total hips, unicondylar knees, and total knees by Dexur. The percentage of cases performed as hospital outpatients varied from 0% at New England Baptist Hospital to 28% at Beaumont Hospital in Royal Oak.

We also report the 2019 top 10 as well as the number of times the hospital has appeared in the top 10 since 2009. A large number of top ten appearances indicates that the hospital may have a long-standing large volume program. Many of these facilities stay in the top spots each year. For example, Hospital for Special Surgery has had the top spot for every survey performed by this newsletter, often with twice as many Medicare procedures as the hospital in the second spot. New England Baptist of Boston and Mayo Clinic Hospital in Rochester Minnesota have also appeared in the top 10 every year for the past 10 years.

Rounding out the top 10 in 2019 were Hoag Orthopedic Institute in Irvine, California, Morristown Medical Center, Mount Carmel New Albany Surgical Hospital, Rush University Medical Center, Beaumont Hospital in Royal, Michigan, Providence Saint John's Health Center in Santa Monica, California, and Sarasota Memorial Hospital in Florida.

Additional information was solicited from these hospitals, including total case volumes, and percentage of cases that were revisions. Responses were received from eight of the top 10.

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Estimates of U.S. Hip and Knee Replacement Procedures: 2018-19

	2018 Estimated Procedures	2019 Estimated Procedures	% Change 2018-2019
Hip	**646,900**	**669,100**	**+ 3.4%**
Total	477,500	497,300	+ 4.1%
Partial	98,900	99,400	+ 0.5%
Revision	64,100	66,500	+ 3.7%
Resurfacing	6,400	5,900	- 7.8%
Knee	**1,011,300**	**1,059,200**	**+ 4.7%**
Primary	843,300	884,000	+ 4.8%
Unicondylar+ PFJ	66,100	67,800	+ 2.6%
Revision	89,700	95,200	+ 6.1%
Patello-Femoral	12,200	12,200	+ 0.0%
Total Hips & Knees	**1,658,200**	**1,728,300**	**+ 4.2%**

Source: iData Research, Inc., Vancouver, British Columbia

Top 10 U.S. Hospitals with Medicare Inpatient and Outpatient Hip and Knee Replacement Procedures 2019

		2019 Medicare Cases	% O/P	10 yr Top 10
Hospital for Special Surgery (330270)	New York, N.Y.	5,140	6%	10
New England Baptist Hospital (220088)	Boston, Mass.	2,693	0%	10
Mayo Clinic Hospital (240010)	Rochester, Minn.	1,793	18%	10
Hoag Orthopedic Institute (050769)	Irvine, Calif.	1,771	7%	4
Morristown Medical Center (310015)	Morristown, N.J.	1,715	12%	4
Mount Carmel New Albany Surg (360266)	New Albany, Ohio	1,684	15%	4
Rush University Med Cntr (140119)	Chicago, Ill.	1,611	23%	2
Beaumont Hospital Royal Oak (230130)	Royal Oak, Mich.	1,601	28%	9
Providence Saint John's Hlth Cntr (050290)	Santa Monica, Calif.	1,543	20%	1
Sarasota Memorial Hospital (100087)	Sarasota, Fla.	1,533	1%	3

Source: Dexur.com

Includes cases assigned to inpatient DRGs 469-470, 461-462, 466-469, and outpatient CPTs 27090-27091, 27120, 27125, 27130, 27132, 27134, 27137-27138, 27437-27438, 27440-27447, 27486-27488

Posted to www.OrthopedicNetworkNews.com on July 28, 2020 at 9:00 AM EDT

Editorial

Stan Mendenhall
Editor
Orthopedic Network News

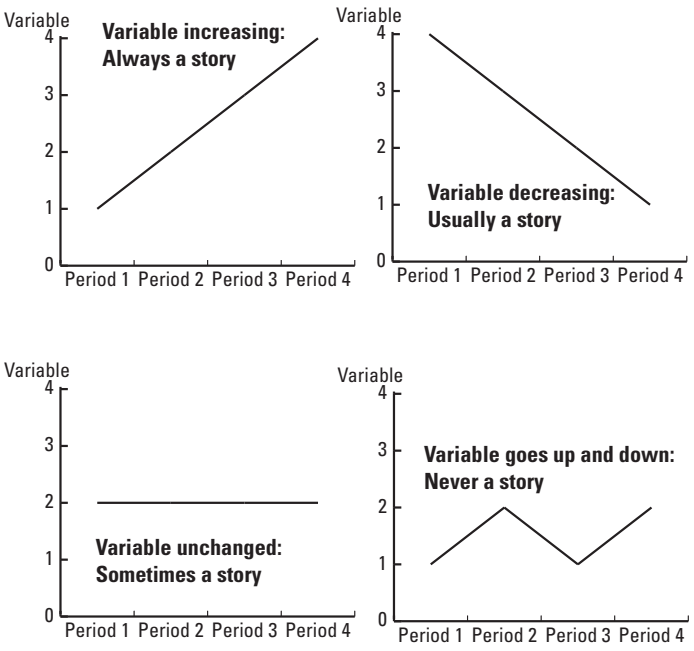
Turning Data into Stories

Over the last 30 years, I have been an avid reader of both the New York Times (Sunday edition), and the Wall Street Journal (Monday-Saturday). I have learned a lot from both of those publications, and have found that we all have the need to communicate "stories" of interest to our readers. Often the raw material for the stories is data. In the case of the Wall Street Journal and New York Times, it may be government or company statistics from any agency related to anything from climate, finance, unemployment, immigration, or other data. What I have observed is that the stories often turn into public policy initiatives from the government, the press, or the arts. And as is the case with any set of data, it can be manipulated to support the agenda of whoever is touting it.

The most common type of data stories involve trends, e.g. trends in income, trends in unemployment, trends in costs, trends in carbon dioxide emissions, that show that things are going up or down. Examples are shown at right. Any time a variable shows an increase, be it sales, employment, temperature, this invites a story. If a variable shows a decrease (e.g. housing prices, tourism dollars), that is usually a story. If a variable hasn't changed between two time periods, (e.g. average resting heart rate), that may be a story, and if a variable goes up and down over several time periods, that cannot be a story.

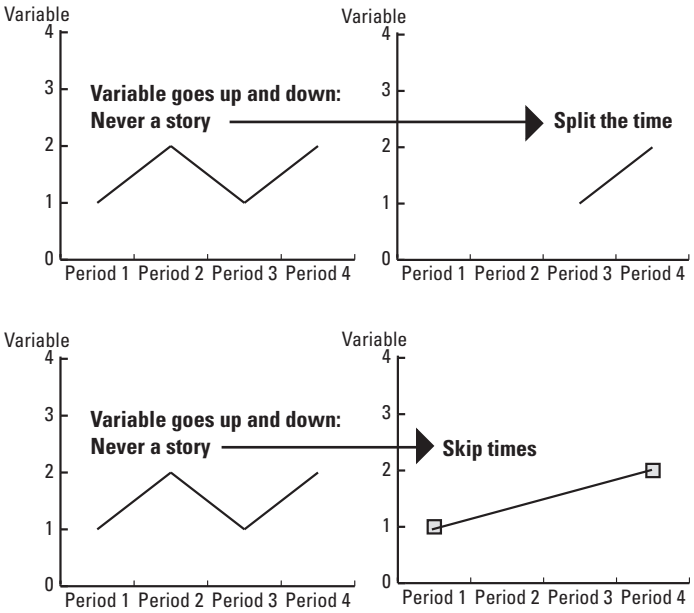
All of us in journalism or the media are often faced with the "empty page" phenomenon, in which we have to struggle to fill blank spaces or time. And so it is often necessary to concoct a story from data that doesn't show an increase or decrease. The second set of graphs shows how uninteresting data can be turned into a newsworthy story. One way is to limit the periods being reported on, and the other is to skip intervening periods. The best example of this is the Dow Jones Industrial average of the stock market which swings wildly from one time period to the next. If you looked at the stock market during the week, you may see increases one day and decreases the next. However, if you just look at the difference between yesterday and today, you will see a trend. The other way to game this is to skip the intervening days and show what it was at the beginning of the week and the end of the week.

Types of Trends and "Story-Worthiness"



Variables (e.g.): Revenue, Costs, COVID-19 cases, Gross National Product, Illegal immigrants, Crime
Period (e.g.): Seconds, minutes, hours, days, weeks, months, quarters, years, decades, centuries

Turning a Non-Newsworthy Story to a Newsworthy Story



So what's this have to do with orthopedics?

As research studies are presented, company figures are offered, and patient statistics are published, there is ample room for distortion of mediocre findings to promote an agenda. This is just an observation of techniques I have observed that have doubtlessly made their way into the popular, academic, and orthopedic press.

Posted to www.OrthopedicNetworkNews.com on July 28, 2020 at 9:00 AM EDT

Top 10 Medicare Hip and Knee Replacement Hospitals (2018-2019)

	Institution	Year	Cases	Medicare[1]	Revisions[2]
1	Hospital for Special Surgery New York City	18 19	11,296 11,153	44% 46%	7% 9%
2	New England Baptist Hospital Boston, Mass.	18 19	NA NA	NA NA	NA NA
3	Mayo Clinic Hospital Rochester, Minn.	18 19	3,237 3,557	58% 50%	14% 15%
4	Hoag Orthopedic Institute Irvine, Calif.	17 18	3,669 4,068	42% 44%	6% 6%
5	Morristown Medical Center Morristown, NJ	18 19	3,649 3,611	46% 47%	6% 7%
6	Mount Carmel New Albany Surg New Albany, Ohio	18 19	4,727 4,059	33% 41%	10% 9%
7	Rush University Med Cntr Chicago, IL	18 19	NA NA	NA NA	NA NA
8	Beaumont Hospital Royal Oak, MI	18 19	2,984 2,991	43% 54%	11% 13%
9	Providence Saint John's Hlth Cntr Santa Monica, CA	18 19	2,413 2,636	59% 59%	4% 4%
10	Sarasota Memorial Hospital Sarasota, Florida	18 19	2,204 2,231	69% 69%	9% 9%

NA: Data not available, incomplete data
[1] % Medicare estimated from Medicare DRG-paid cases (reported by CMS) divided by cases reported by individual hospitals unless otherwise noted.
[2] Number of hip and knee revisions reported by hospital divided by total procedures.

continued from page 1

A low percentage of Medicare procedures indicates that the hospital is probably performing higher-paying non-Medicare joint replacements, while a higher percentage indicates more Medicare patients with potentially lower reimbursement. In this group, Sarasota had the highest Medicare percentage of patients at 69%, and Mount Carmel New Albany had the lowest at 41%.

A high percentage of revision cases may indicate that the hospital may be a referral center for difficult to treat revisions. The Mayo Clinic reported 15% of their joint replacements as revision cases; the Mayo Clinic has consistently had the highest percentage of revision cases in the top 10 hospitals for many years.

It is difficult to discern all of the joint replacement procedures performed at specific hospitals. For example, the decline in the number of procedures at Mount Carmel New Albany Surgery Center coincides with the growth in procedures at the stand-alone ambulatory surgery center White Fence Surgical Suites, in Columbus, Ohio, which is independent of the hospital.

The Shift to Outpatient Joint Replacements

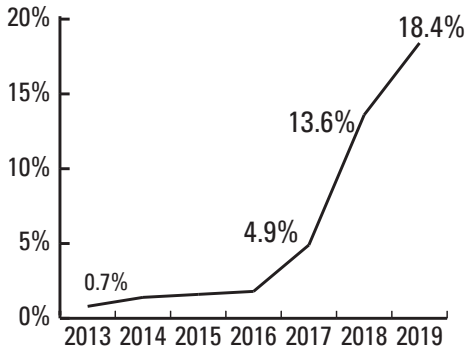
As hip and knee replacements has become more routine and efficient, insurers have incentivized providers to perform the procedure in less expensive outpatient surgery departments (HOPDs), or ambulatory surgery centers (ASCs).

The biggest incentive for this push in several decades was the decision by CMS in 2018 to take knee replacements off of the "inpatient only" list. This has been followed by the removal of total hip replacement from the inpatient only list in 2020. This meant that hospitals performing knee replacements in HOPDs would be reimbursed by Medicare. Although there are now more Medicare-certified ASCs than hospitals, reimbursement for Medicare joint replacements has not yet been approved for procedures performed in ASCs, even though many commercial insurers have selectively reimbursed ASCs for non-Medicare joint replacements.

According to Dexur, the percentage of Medicare joint replacements that were performed in hospital outpatient facilities increased from 4.9% in 2017 to 13.6% in 2018, and 18.4% in 2019. With the approval of total hip replacements for hospital outpatient payment, this will likely increase.

The movement to outpatient procedures has not been uniform across individual states. Data show that the states with the highest outpatient penetration in 2019 were Delaware, Georgia, and Hawaii, all of whom reported at least 30% of their joints in outpatient settings. The lowest were hospitals in Kansas, New York, Connecticut, and Oklahoma, each of whom reported less than 10% as outpatients.

Percentage of Medicare Joint Replacements that were Outpatient



Source: www.dexur.com

Medicare Hospital Outpatient Joint Replacements, by State

State	2017	2018	2019	Chg 17-19
Overall Average	**4.9%**	**13.6%**	**18.4%**	**+ 13.5%**
Highest HOPD Penetration				
Delaware	7%	28%	35%	+ 28%
Georgia	6%	27%	33%	+ 27%
Hawaii	4%	27%	30%	+ 26%
Lowest HOPD Penetration				
Kansas	5%	5%	9%	+ 4%
New York	3%	6%	9%	+ 6%
Connecticut	5%	4%	9%	+ 4%
Oklahoma	2%	7%	9%	+ 7%

Source: www.dexur.com

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COVID-19 and Orthopedics

As of this writing, any news has been displaced by speculation on COVID-19—its progression, its lethality, the impact of mitigation measures as well as comorbid conditions. Paralleling the public health speculation is the discussion on businesses—small businesses, unemployment, tourism and travel, as well as hospitals and healthcare organizations.

Most of the impact on healthcare organizations has been the financial reporting from publicly traded companies or surveys of hospitals and surgeons on their willingness or ability to increase procedure volumes. Publicly traded companies have reported 2nd quarter (April-June 2020) declines of between 30% and 37% for the spinal implant sales at NuVasive, SpineGuard, DePuy Synthes Spine, Medicrea and Implanet. Reconstructive surgery sales were reported to have similar declines during the same period.

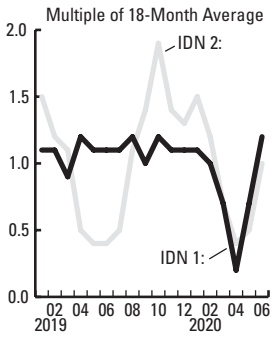
While none of us can predict the future, what we can report on is selective statistics on hospital purchases of critical components. While the data that we often receive is less than reliable for this type of speculation, we have focused on two integrated delivery networks (IDNs) whose data has been consistently accurate for this type of reporting. One IDN (IDN 1) comprises 86 hospitals and included over 80,000 reconstructive surgery and spinal fusion procedures between January 2019 and June 2020, and the second IDN included over 14,000 cases in this time period and included 6 hospitals. While IDN 1 included more cases, it did not include trauma procedures. IDN 2 included trauma procedures but had limited spine procedures from 2020.

The data systems that we use to collect this information is highly integrated with the purchasing systems. Therefore the notorious weaknesses in purchasing systems are reflected in these statistics. These weaknesses include the disparity between the number of procedures and the volume of purchases, the inability of purchasing systems to identify specific procedures, and the tendency to "add-on" purchases after procedures have been completed.

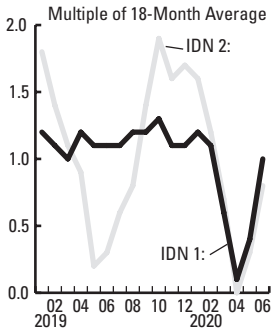
Having said that, the purchasing systems often can be used as an index into the number of surgeries—the number of femoral stems can often be used as a proxy for the number of hip replacement surgeries, the number of femoral components for knee implants can be used to estimate the number of knee procedures, since neither are likely to be purchased for something other than the procedure they were designed for.

The "index" components examined here are coated femoral stems as a proxy for hip procedures, knee femurs as a proxy for

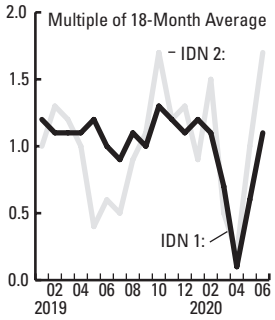
Changes in Purchases of Orthopedic "Recon" Components, by Month, January 2019-June 2020



Coated Femoral Stems

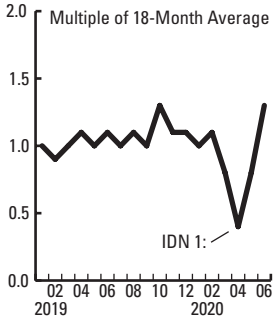


Knee Femurs

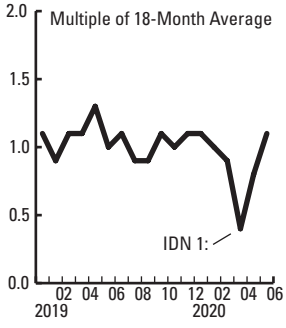


Shoulder:
Humeral Heads/Glenospheres

Changes in Purchases of Orthopedic Spinal Fusion Components, by Month, January 2019-June 2020



Lumbar Fusions:
Pedicle Screws



Cervical Fusions:
Spinal Plates

Source: Orthopedic Research Network (ORN)

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knee procedures, shoulder humeral heads or glenospheres for total or reverse shoulder procedures, lumbar pedicle screws for lumbar fusions, cervical plates for cervical fusions, cephalomedullary nails for estimates of hip fracture repairs, wrist plates for wrist fracture repairs, fixation plates and screws for fractures of other bones, and soft tissue attachments as a proxy for sports medicine procedures.

The common wisdom has been that COVID-19 has impacted elective surgical procedures—namely reconstructive joint replacements (hips, knees, and shoulders), spinal fusions, and sports medicine procedures. Although trauma procedures have also declined somewhat because of reduced driving and sports activities, they would not be affected as much as the elective procedures.

To calculate the number of procedures, the average number of key components was calculated between January 2019 and June 2020, and an index representing the multiple of this average was calculated for each of the IDNs for each month between January 2019 and 2020, and then graphed.

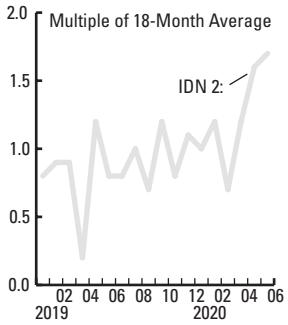
The first three graphs on page 4 display the index by month between January 2019 and June 2020 for reconstructive procedures for IDN 1 and IDN 2. As can be seen, an almost idnetical pattern shows the extremely low dip in procedures in April 2020 when elective surgical procedures were largely abandoned in the United States followed by increases in both May and June. Note also that IDN 2 shows exteme seasonality in these procedures in the summer months of 2019, typically correspond to summer vacations when fewer procedures are performed.

The trend in lumbar pedicle screws and spinal plates at IDN 1 show a similar dip in April 2020, although it was not as deep as it was for joint replacements. IDN 2 did not report spine procedures for April 2020 through June 2020, so it is not possible to report their changes.

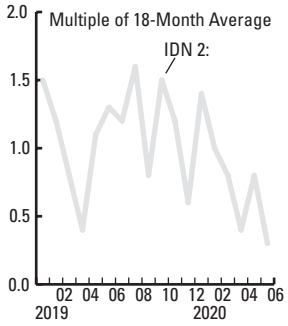
The fracture fixation trends are displayed at right for IDN 2. Although there are differences between the months and a decrease in April 2020 compared to other months, they are not as pronounced and dramatic as those displayed for joint replacements. Finally, the sports medicine trends display a similar to that of reconstructive surgeries with dramatic declines in April followed by an increase in May and June.

While the impact of the resurgence of COVID-19 in July 2020 in the US is not reflected here, nor are any predictions possible on the future of the virus, the underlying data from these sources support the narrative that elective procedures showed dramatic drops earlier in 2020 while the number of trauma procedures, although impacted, was less dramatic.

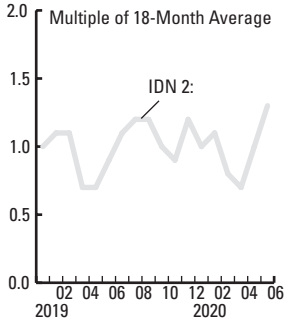
Changes in Purchases of Orthopedic Trauma Components, by Month, January 2019-June 2020



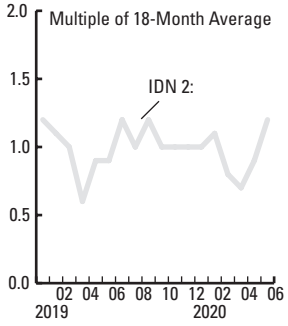
Cephalomedullary Nails



Wrist Plates

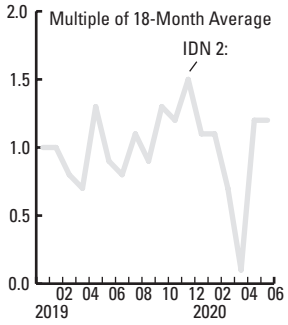


Fixation Plates



Cortical Screws

Changes in Purchases of Orthopedic Sports Medicine Components, by Month, January 2019-June 2020



Bone Anchors

Source: Orthopedic Research Network (ORN)

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The 2020 WW Hip & Knee Implant Market

The world-wide (WW) hip and knee implant market increased 2.6% between 2018 and 2019 to over $17.1 billion, according to data compiled by ORTHOWORLD, of Chagrin Falls, Ohio. Starting in 2017, we are reporting the worldwide sales rather than US sales. US sales accounted for about 59% of the 2019 sales according to ORTHOWORLD. The change in US sales for 2006-2019 for hip and knee implants are chronicled in the graphic at the right. Sales growth averaged high-single digits until 2008, and between 2010 and 2011, the industry actually contracted 1.4% due to a slowdown of procedures and pricing pressure. As of this writing, the impact of COVID-19 on the hip and knee implant procedures for 2020 has only been estimated, although the first two quarters reported a double-digit decrease over the same two quarters of 2019.

In 2019, Zimmer Biomet had the largest share in the market with $4.7 billion (27.7 share) followed by Stryker with $3.8 billion (22.4 share), DePuy Synthes with $3.0 billion (17.4) share, and Smith & Nephew at $1.7 billion (10.1 share). Zimmer Biomet lost 0.4 share, Stryker increased 0.8 share, DePuy Synthes decreased 0.5 share, Smith & Nephew reported no change in their share of the market, while the category of "other" gained 0.1 share as well. The ORTHOWORLD universe of "Other" manufacturers includes over 150 manufacturers that accounted for 22.3% of the world-wide sales of hip and knee implants in 2019.

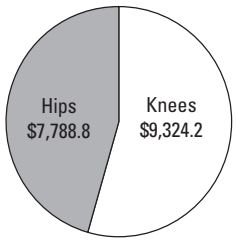
In examining the hip and knee implant market separately, the leaders and dynamics are identical. Zimmer Biomet led both the knee and the hip market with 24.8% of the sales of hips and 30.1% of the sales of the knees in 2019. Stryker was number two in both categories with 21.2% of the hip sales and 23.4% of the knee sales. DePuy Synthes had sales of $1.5 billion of hip implants (18.9 share) and $1.5 billion in knee sales which was 16.2% of that total. Smith & Nephew accounted for $622 million of the hip sales (8.0%) and $1.1 billion of the knees (11.9%).

It should be noted that the calculation of market shares for each of these companies is somewhat of an art, because of the different ways that they report their sales. For example, Smith & Nephew is based in the United Kingdom, so their financials must be translated from pound sterling into dollars. Some companies will report sales in North America, which would include Canada, while others will report US sales, and yet others will report sales for the "Americas." In summary, it is a logistical and numerical challenge to report this information consistently between years and between companies.

WW Hip and Knee Implant Markets and Shares, 2018-2019

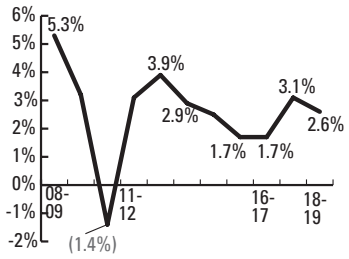
Total WW 2018 Hips/Knees Sales: $16,676.2 million
Total WW 2019 Hips/Knees Sales: $17,113.0 million
2018-2019 Increase + 2.6%

2019 World-Wide Sales Distribution



Source: ORTHOWORLD

% Sales Change US & WW Hip and Knee Implants



Source: Orthopedic Network News, 2006-2017
Note: 2008-2016 is US Sales change, 2016-2019 is WW sales change

HIP AND KNEE IMPLANTS

Company	Sales 2018	($ mill) 2019	WW Growth	2018 Share	2019 Share	Share Change
Zimmer Biomet	$4,695.1	$4,745.2	+ 1.1%	28.2%	27.7%	- 0.4
Stryker	$3,606.3	$3,835.4	+ 6.4%	21.6%	22.4%	+ 0.8
DePuy Synthes	$2,985.4	$2,982.0	- 0.1%	17.9%	17.4%	- 0.5
SNN	$1,692.0	$1,734.0	+ 2.5%	10.1%	10.1%	nc
Other	$3,697.4	$3,816.4	+ 3.2%	22.2%	22.3%	+ 0.1
WW Market	**$16,676.2**	**$16,676.2**	**+ 2.6%**	**100.0%**	**100.0%**	

HIP IMPLANTS

Company	Sales 2018	($ mill) 2019	WW Growth	2018 Share	2019 Share	Share Change
Zimmer Biomet	$1,921.4	$1,934.6	2.5%	25.3%	24.8%	- 0.5
Stryker	$1,578.5	$1,652.1	3.3%	20.8%	21.2%	+ 0.4
DePuy Synthes	$1,450.7	$1,470.7	1.3%	19.1%	18.9%	- 0.2
SNN	$613.0	$622.4	2.3%	8.1%	8.0%	- 0.1
Other	$2,018.7	$2,109.1	5.3%	26.6%	27.0%	+ 0.4
WW Market	**$7,582.3**	**$7,788.8**	**2.7%**	**100.0%**	**100.0%**	

KNEE IMPLANTS

Company	Sales 2018	($ mill) 2019	WW Growth	2018 Share	2019 Share	Share Change
Zimmer Biomet	$2,773.7	$2,810.6	+ 1.3%	30.5%	30.1%	- 0.4
Stryker	$2,027.8	$2,183.3	+ 7.7%	22.3%	23.4%	+ 1.1
DePuy Synthes	$1,534.7	$1,512.0	- 1.5%	16.8%	16.2%	- 0.6
SNN	$1,079.0	$1,111.6	3.0%	11.8%	11.9%	+ 0.1
Other	$1,678.7	$1,706.7	1.7%	18.5%	18.3%	- 0.2
U.S. Market	**$9,093.9**	**$9,324.2**	**2.5%**	**100.0%**	**100.0%**	

Other includes approximately 150 companies for the hip and knee market including Aesculap, Medacta, Microport Orthopedics, ConforMIS, Exactech, DJO, Waldemar Link, Amplitude, Mathys, Corin, Kyocera, and Lima.

Hip and Knee implants include implants, instruments and surgical assistance systems, e.g. robotics and navigation, to replace or revise failed hip and knee joints.

Source: ORTHOWORLD, Inc.

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Orthopedic Network News (ONN) further reviewed some of the major brands of the leading manufacturers of hip and knee implants—Zimmer Biomet, Stryker, DePuy Synthes, and Smith & Nephew from the Orthopedic Research Network (ORN), a group of several hundred hospitals that submit data to ONN or Curvo Labs. For convenience sake, the sales of total, partial, and revision hips have been combined for hip implants, and total, unicondylar, and revision knees for knee implants.

For the leading manufacturer of hip implants in the ORN, Stryker, the Accolade, Restoration, and Secur-Fit were the leading three brands which accounted for 85% of their hip sales. Although there are literally thousands of components that Stryker sells that are branded as "Accolade" brand, the Accolade systems accounted for about two-thirds of the sales of hip systems at Stryker in both 2018 and 2019. DePuy Synthes was led by Actis, Corail, and Summit which together accounted for about 71% of their hip sales in 2018 compared to 76% in 2019. Zimmer Biomet sold many more systems—the top three brands, Taperloc, M/L Taper, and Avenir only accounted for 51% of their sales in 2018 and 53% in 2019. Finally, Smith & Nephew's Polarstem, Synergy, and Anthology systems accounted for about 75% of their hip implant sales in both 2018 and 2019.

The top 4 manufacturers of knee implants shared a distribution of brand consolidation. Stryker's Triathlon system accounted for 89% of their knee implant sales. It should be stated that the Triathlon brand applies to many sub-categories such as revision knees and cementless knees. The top three brands at Stryker accounted for 99% of their knee implant sales. Zimmer Biomet's Vanguard, Persona, and NexGen accounted for 87% of their sales, DePuy's Attune and Sigma accounted for 88% of their sales, while Smith & Nephew's Legion, Journey and Genesis accounted for 94% of their 2019 US sales of knee implants.

ONN identified the "fastest growing hip and knee implant companies" based on sales changes at 224 hospitals that reported sales of hip and knee implants in both 2018 and 2019. Because most of these companies sales are relatively low, ONN reports a range of percentage increases rather than an absolute number to eliminate the distortion accompanying small numbers. Based on the analysis, the fastest growing hip implant companies were ConforMIS, United Orthopedic Company, Maxx Orthopedics, DJO Surgical, Arthrex, Lima, Next Step Orthopedics, and Orthopedic Development Corporation. All of these reported at least 20% sales growth, while some reported over 100% sales growth. The fastest growing knee implant companies included Onkos Surgical, Aesculap, United Orthopedic Company, Corentec, Arthrosurface, DJO Surgical, and Lima USA, all of whom reported over 20% sales growth in the hospital data reviewed. It should be stated that much of this sales growth reflects relatively new companies, or companies that specialize in "niche" products, such as Onkos Surgical, whose specialty is oncology-related orthopedic implants. It should be emphasized that the actual sales at these companies is not public information, so it is possible that they may not see the sales increases reported here.

Distribution of Sales, Selected Hip and Knee Implants 2018-19

Hip Implants

Mfg	Top 3 Major Brands of Hips	Mfg ORN $ 18 Mix	Mfg ORN $ 19 Mix	Change 18-19
Stryker	Accolade	67%	66%	- 1
	Restoration	13%	10%	- 3
	Secur-Fit	7%	9%	+ 2
	Other	13%	15%	+ 2
		100%	100%	
DePuy Synthes	Actis	23%	31%	+ 8
	Corail	24%	27%	+ 3
	Summit	24%	18%	- 6
	Other	29%	24%	- 5
		100%	100%	
Zimmer Biomet	Taperloc	34%	34%	nc
	M/L Taper	12%	11%	- 1
	Avenir	5%	8%	+ 3
	Other	49%	47%	- 2
		100%	100%	
Smith Nephew	Polarstem	36%	29%	- 7
	Synergy	23%	24%	+ 1
	Anthology	16%	22%	+ 6
	Other	25%	25%	nc
		100%	100%	

Knee Implants

Mfg	Major Brand	Mfg ORN $ 18 Mix	Mfg ORN $ 19 Mix	Change 18-19
Stryker	Triathlon	86%	89%	+ 3
	Restoris	3%	10%	+ 7
	GMRS	1%	0%	- 1
	Other	10%	1%	-9
		100%	100%	
Zimmer Biomet	Vanguard	38%	47%	+ 9
	Persona	33%	28%	- 5
	NexGen	14%	12%	- 3
	Other	15%	13%	- 2
		100%	100%	
DePuy Synthes	Attune	51%	61%	+ 10
	Sigma	36%	27%	- 9
	LPS	6%	7%	+ 1
	Other	7%	5%	- 2
		100%	100%	
Smith Nephew	Legion	19%	34%	+ 15
	Journey	31%	31%	nc
	Genesis	32%	29%	- 3
	Other	18%	6%	- 12
		100%	100%	

Fastest Growing Hip and Knee Implant Companies (US), 2018-2019

Fastest Growing Hip Implant Manufacturers		Fastest Growing Knee Implant Manufacturers	
Manufacturer	2018-2019 Increase	Manufacturer	2018-2019 Increase
ConforMIS	>100%	Onkos Surgical	>100%
United Orthopedic Company	>100%	Aesculap	>100%
Maxx Orthopedics	>100%	United Orthopedic Company	>100%
DJO Surgical	>50%	Corentec	>100%
Arthrex	>40%	Arthrosurface	>50%
Lima US	>40%	DJO Surgical	>40%
Next Step Orthopedics	>25%	Lima USA	>40%
Orthopedic Development Corp	>20%		

Source: ORN, 2018-2019. Based on sales increases for 224 US hospitals reporting sales of hip or knee implants in both 2018 and 2019.

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The Publicly Traded Companies

Many of the major US hip and knee implant manufacturers are publicly traded. As public companies, their financial performance is subject to quarterly and annual reporting through the Securities and Exchange Commission (SEC). Theoretically, one can impute how a company spends its money on products from their filings, however that is often challenging because of mergers and acquisitions or having publicly traded orthopedic companies buried inside larger ones. For example, DePuy Synthes is buried within the public reporting of Johnson & Johnson where the expenses of orthopedic products are not detailed.

This year *Orthopedic Network News* was able to analyze the reports from Zimmer Biomet, Stryker, Smith & Nephew, Wright Medical Group, and MicroPort. There are other smaller privately-held companies, but these are not included in this analysis.

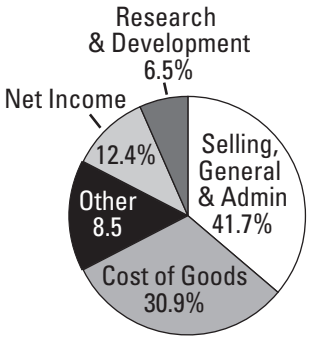
The 10-K's submitted by the companies separate expenses into categories of cost of goods sold, selling/general/administrative expenses, research and development, taxes, and net income. Cost of goods sold is the cost of materials and manufacturing of the implants by the company and is measured as a percentage of sales. Payments to surgeon consultants may be counted in R&D or in cost of goods, depending on the company's policy.

In reporting the "average" expenses in these categories, it is possible to report the "overall average" based on taking the total expenses and sales for all companies, or reporting the "average of the averages" for each company. In prior years we have reported "average of the averages" but given some of the significant swings in profitability for Wright Medical, the overall average is reported. The disadvantage of this approach is that the inclusion of large companies, such as Stryker, will skew the overall averages based on their specific experience.

Based on the "overall average" metric, the largest component of these companies' expenses was selling, general, and administrative expenses, which averaged 41.7% in 2019, down from 42.5% in 2018. Research and development averaged 6.5% of sales in 2010, up from 6.0% in 2018, and the cost to manufacturer (cost of goods) was the second largest category of expenses at 30.9% for the group, about the same as last year.

As a point of reference, the world-wide (WW) sales of hip and knee implants are reported. Zimmer Biomet reported $4.7 billion in WW hip and knee implant sales, and Stryker reported $3.2 billion. Other companies reported WW sales of other groups of implants: MicroPort reported "All orthopedic" sales. These totals may differ from those on page 4 because of how the companies have classified their sales.

Components of an Orthopedic Implant



Components of a $5,000 Implant

Selling, General & Administrative	$2,085
Manufacturing	$1,545
Net Income	$620
Research and Development	$325
Other	$425

*Source: **Orthopedic Network News** estimates, based on average of 2019 performance of 6 companies.*

Comparison of 2017-2019 Key Financial Statistics, Publicly Traded Orthopedic Implant Companies

Manufacturer	$ (mills)	Cost of Goods $ (mills)	% of Sales	Research & Development $ (mills)	% of Sales	Selling General & Administrative $ (mills)	% of Sales	WW Hip & Knee Sales $ (mills)	% of Sales	Net Income $ (mills)	% of Sales	Cnstnt Crrncy WW Sales % 18-19
Stryker	14,884.0	5,188.0	34.9%	971.0	6.5%	5,356.0	36.0%			2,083.0	14.0%	9.4%
Stryker Ortho	*5,252.0*							*3,198.0*	*60.9%*			
DePuy Synthes Recon	8,839.0							2,918.0	33.0%			
Zimmer Biomet	7,982.2	2,252.6	28.2%	449.3	5.6%	3,343.8	41.9%	4,745.2	59.4%	1,131.5	14.2%	0.6%
Smith & Nephew	5,138.0	1,338.0	26.0%	292.0	5.7%	2,693.0	52.4%	1,655.0	32.2%	600.0	11.7%	4.8%
Wright Medical Group	920.9	188.6	20.5%	74.1	8.0%	614.7	66.7%	na		(144.2)	(15.7%)	10.1%
MicroPort *	793.5	229.1	28.9%	151.5	19.1%	394.6	49.7%	232.4	29.3%	29.0	3.7%	(1.7%)
Average (2019)			30.9%		6.5%		41.7%		35.1%		12.4%	4.0%
Average (2017)			30.8%		6.0%		42.5%		44.1%		12.3%	5.1%
Average (2016)			30.8%		5.5%		40.2%		42.3%		7.8%	7.7%

** MicroPort financials include acquisition of LivaNova's CRM business*

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Hospital Resources and Implant Cost Management — a 2019 Update

The average cost of a hip and knee implant for US hospitals in 2019 decreased to $4,965, a 0.9% decrease from 2018. This estimate is based on data obtained from a group of 294 hospitals that submitted data in either 2018 or 2019. Note that the data reported here are through calendar year 2019, and thus the impact of the COVID is not reported. It should be noted that not all hospitals reported procedures in both years, so there may be some distortion in trends based on this methodology. Note also that the implant costs per case include not only implants, but also bone cement, bone grafts and substitutes, instruments, robotics (usage fees/disposables), soft tissue balancing, loaner fees, and other supply costs associated with the surgeries. These represent 4.0% of the total spend of the overall costs, down from 3.5% last year. The reduction of these peripheral costs reflect the way that much of the data is collected, in which purchases for ancillary devices are often segregated from purchases of implants.

The overall ASP for all hip procedures declined 2% to $4,788 while the overall knee implant costs remained steady at $5,093. Increases were reported for revision hips and revision knees, while total hips, partial hips, total knees, and partial knees registered declines.

The change in the mix of procedures in the ORN between 2018 and 2019 was an increase in total, partial, and revision hips with a decrease in partial and total knees. The share of revision knees did not change. Some of the share changes may reflect movement of procedures to the outpatient setting where the ORN coverage is not as complete.

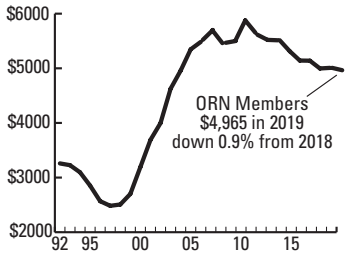
Total Hips

The trends in total hips reported in previous years are apparent in the 2019 data—the virtual disappearance of hard-on-hard surfaces, which include metal on metal hips or ceramic on ceramic hips, the growth of ceramic heads in total hip constructs, and the dominance of coated hip stems over uncoated hip stems.

Hard-on-hard hips accounted for less than 1% of the cases in the 2019 ORN, down from as much as 43% in 2007. Ceramic heads with coated hip stems and poly liners accounted for over 74% of the cases in 2019, while metal heads with coated hip stems accounted for almost 13% of the cases in 2019. Coated hip stems, in general, have increased from 40% of the stems in 1999 to 95% in 2019, while the uncoated, generally cemented hip stems declined from 54% of the stems in total hips in 1999 to 4% in 2019.

Average Cost of Implant Components by Procedure 1992-2019

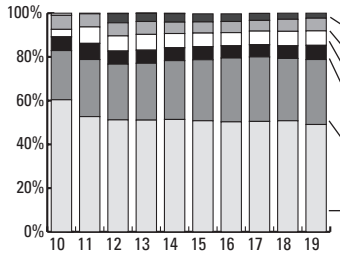
Implant Cost/Procedure



	2018	2019	% Chg
Overall	$5,008	$4,965	- 0.9%
Total Hip	5,079	5,004	- 1.5%
Primary Knee	4,485	4,325	- 3.6%
Partial Hip	3,106	2,969	- 4.4%
Partial Knee	4,297	3,945	- 8.2%
Revision Hip	5,713	5,730	+ 0.3%
Revision Knee	10,053	11,247	+ 11.9%
All hip cases	$4,884	$4,788	- 2.0%
All knee cases	$5,091	$5,093	nc

Source: ORN

ORN Market Share by Procedure, 2010-2019

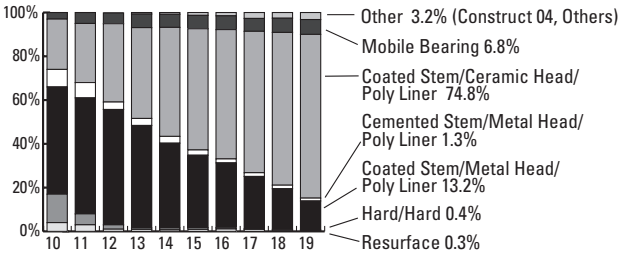


	2018	2019	Chg
Partial Knee	2.8	2.3	- 0.5
Revision Hip	5.5	5.8	+ 0.3
Revision Knee	6.6	6.6	nc
Partial Hip	5.8	6.5	+ 0.7
Total Hip	28.5	29.7	+ 1.2
Total Knee	50.8	49.1	- 1.7

Source: ORN

Trends in Total Hip Constructs, 2010-2019

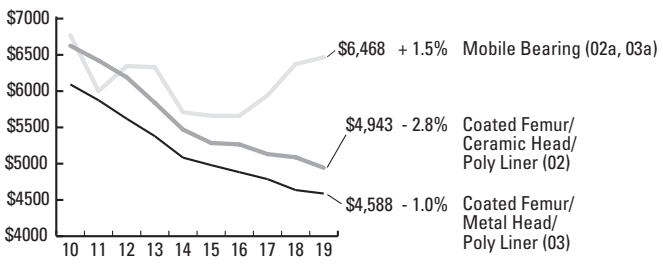
% of Cases by Construct Type, 2010-2019



Summary	1999	2010	2019
Coated Hip Systems (02, 02a, 03, 03a)	40%	92%	95%
Uncoated Hip Systems (04, 05)	54%	7%	4%

Trends in ASPs for Total Hip Constructs, 2010-2019

Average Selling Price by Construct Type 2010-2019



Source: Orthopedic Research Network (ORN), 2010-2019

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The mobile bearing hips registered a 1.5% increase in average selling price (ASP) between 2018 and 2019, while the more prominent constructs which used coated hip stem with either ceramic or metal heads registered declines of 1.0% and 2.8%. (See page 9).

Component Usage and Trends in Hip Replacements

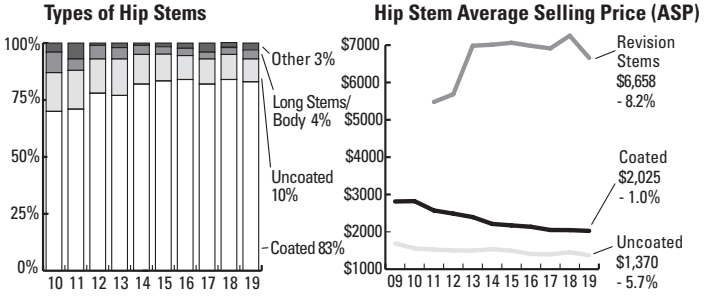
According to the ORN, the percentage of hip stems designated as coated were 83% of the stems, compared to 10% uncoated, 4% long or revision stems, and 3% other stems. Revision hip stems averaged $6,658, down 8.2% from 2018, coated hip stems averaged $2,025, a 1.0% drop from 2018, and uncoated hip stems averaged $1,370, down 5.7% from 2018. It should be noted that modular revision stems, such as Zimmer Biomet's Arcos which use multiple components to create a revision stem, are included in the calculation of revision hip stem prices.

Ceramic heads accounted for 70% of the femoral heads in the 2019 ORN, up from 66% in 2018. The ASP for a ceramic head was $800 in 2019, down 11.9% from 2018. The ASP for a metal head was $472, down 13.9% from 2018.

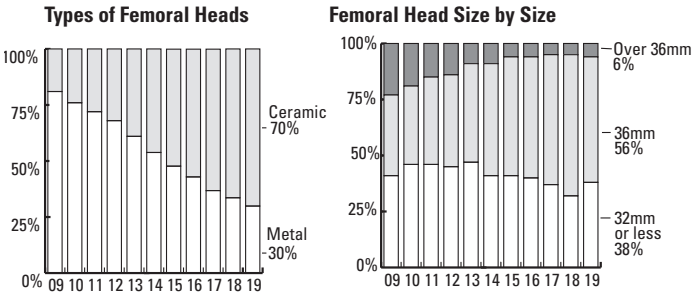
The size of the femoral heads were split into the 32mm and less, 36mm, and greater than 36mm. In 2019, 38% of the ceramic and metal femoral heads were 32mm and less, 56% of them were 36mm, and 6% were larger than 36mm. Until hardened acetabular liners appeared on the market in 2002, femoral heads were available in sizes of 22, 26, 28, and 32 millimeter diameters. Larger heads were more "anatomic" but had the disadvantage of providing a greater surface area with the acetabular liner from which polyethylene wear debris could originate. This was thought to be one of the main causes of femoral osteolysis. Beginning in 2002, femoral heads have gotten larger so that by 2007, the majority of femoral heads were over 32mm in diameter, up from basically none in 2001.

Acetabular liners have been the most significant contributor to changes in orthopedic practice with "hard" surfaces and improved polyethylenes. In 2019, cross-linked poly liners accounted for about 77% of liners sold, the "conventional polyethylene" about 4% of liners, and the anti-oxidant enhanced liners accounted for 19% of the liners. The advantage of anti-oxidant enhanced polyethylene is that it absorbs the free radicals that are released during the cross-linking process. (The most frequently used material for enhancing polyethylene has been Vitamin E.) The average prices of these liners represent the pricing differential for "newer" technology: the regular polys had an ASP of $634 in 2019, the cross-linked poly $764, and the anti-oxidant poly cost $1,012 in the 2019 ORN. All reported significant declines in average selling prices.

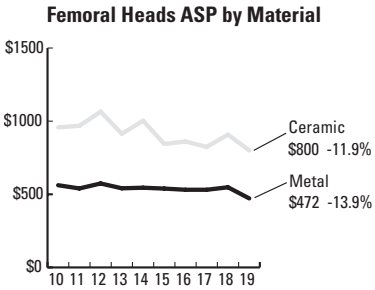
Usage and ASPs of Femoral Stems, 2010-2019



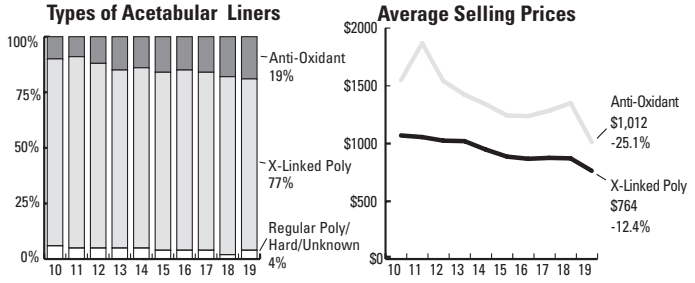
Usage, Size, and ASPs of Femoral Heads, 2010-2019



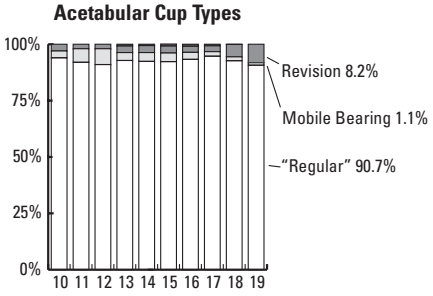
Trends in Femoral Head ASP, 2010-2019



Materials and ASPs of Acetabular Liners, 2010-2019



Acetabular Cups and Shells, Materials, and ASP 2010-2019



Source: Orthopedic Research Network (ORN), 2010-2019

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The acetabular cups and shells were designated as "regular", mobile-bearing, or "revision". The "regular" cups and shells accounted for over 91% of the shells, mobile bearing shells accounted for 1% of these in the 2019 ORN, and revision cups/ shells accounted for an additional 8% in 2019.

The mobile-bearing cups include two-piece cups which include a normal cup and a mobile bearing liner and three-piece cups with a cup, mobile bearing liner, and poly liner. There has been an increase in the use of three-piece vs. two-piece mobile bearing cups between 2015 and 2019. In 2015, 35% of the cases used three-piece mobile bearing cups, which increased to 81% of the cases in 2019. The ASP of cases with two-piece cups was $4,803 in the 2019 ORN compared to $5,850 for cases with the three-piece cup.

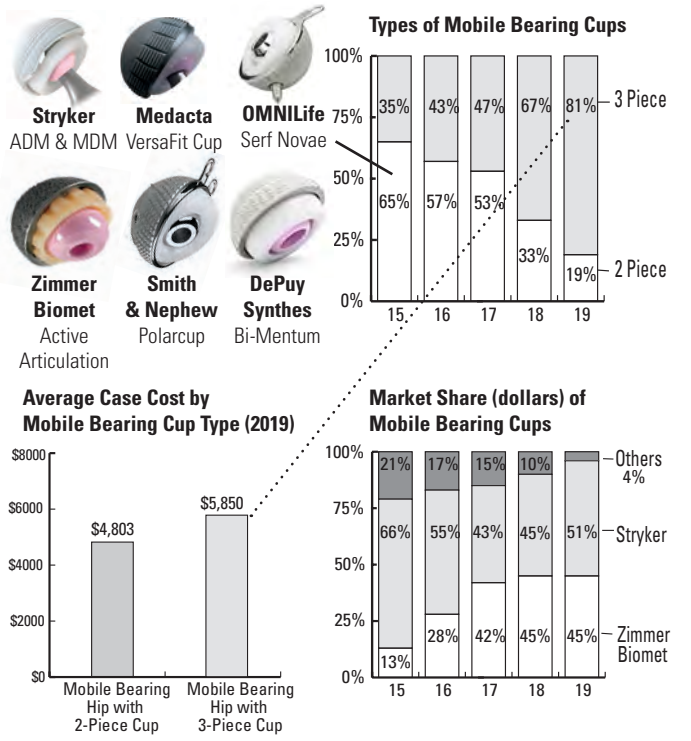
The 2019 ORN indicates an increase in the number of "ultraporous" coatings of acetabular shells, i.e. those with names such as Gription (DePuy), Regenerex and Trabecular Metal (Zimmer Biomet), Tritanium (Stryker), and BioFoam (MicroPort). The percentage of shells with the ultraporous coating increased from practically nothing in 2000, to 59% in 2019. In 2019, the average selling price of an ultraporous shell was $1,322 compared to $1,002 for a non-ultraporous shell. The uptick in both utilization and the average selling price for the ultra-porous shells reflects a change in the sample data.

The design of the cups can also drive costs. In response to the need to improve fixation of the cup, manufacturers have provided holes in the cups to screw them into the pelvis. Because the way of counting holes is inconsistent across manufacturers, ONN has grouped them into Solid, 1-2 hole, 3-4 hole, and over 4 hole. There has been a marked increase in the number of holes in cups: in 2013, 65% of the cups were 3 or more holes, and by 2018, 87% of the cups had 3 or more holes.

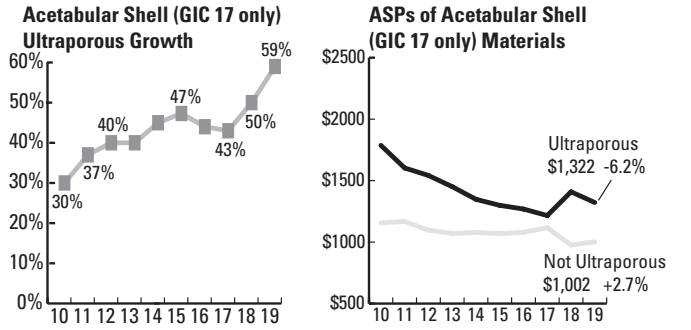
In general, more holes provides greater flexibility, however, more holes generally increase the shell cost, and the cost of screws (about $59 each) and the cost of plugs to fill unused holes (about $79 each). This will increase the overall cost of implanting the cup into the acetabulum. According to the ORN, the number of screws used in cups has stayed relatively constant at about 0.9 screws per total hip case between 2014 and 2019. However, in 2019, over 98% of the acetabular shells had at least one hole and 48% of the total hip cases had no screws, indicating that there are a large number of cups implanted with holes that had no screws.

continued on page 14

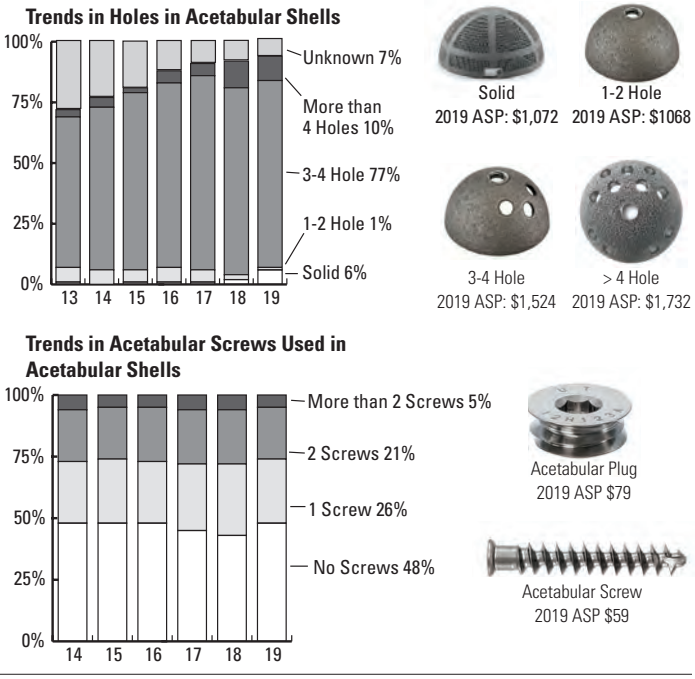
Mobile Bearing Cups, 2015-2019



Materials of Acetabular Shells, 2010-2019



Trends in Number of Holes in Acetabular Shells, Screws, 2013-2019



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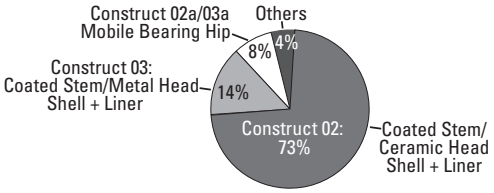
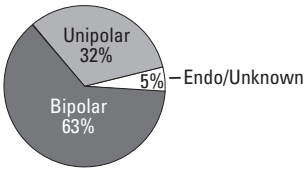
The 2020 U.S. Hip Implant Price Comparison

CONSTRUCTS OF TOTAL HIPS

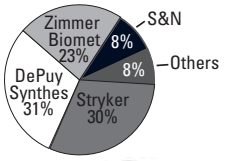


CONSTRUCTS OF PARTIAL HIPS



Top 7 Coated Stem, Ceramic on Poly Constructs

Market Share (cases) 2019 ORN



Accolade II stem, Tritanium cup, X3 poly SYK
Stem 6721-0535
Head 6570-0-136
Shell 702-04-52E
Liner 623-00-36E
2019 ASP $4,664

Actis DuoFix stem, Pinnacle shell w/Gription, AltrX Liner DPY
Stem 1010-11-060
Head 1365-36-310
Shell 1217-32-052
Liner 1221-36-052
2019 ASP $4,933

Corail stem, Pinnacle shell w/Gription, AltrX Liner DPY
Stem 3L92502
Head 1365-36-310
Shell 1217-32-052
Liner 1221-36-052
2019 ASP $4,707

TaperLoc 133 HO stem, G7 shell and liner ZBH
Stem 51-104120
Head 650-1057
Shell 010000663
Liner 010000858
2019 ASP $4,920

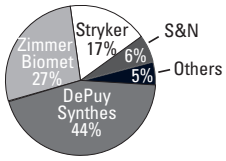
M/L Taper stem, TM shell, XP liner ZBH
Stem 00-7711-011-00
Head 00-8775-036-02
Shell 00-6202-052-02
Liner 00-6305-050-036
2019 ASP $4,920

Summit stem, Pinnacle shell w/Gription, AltrX Liner DPY
Stem 1010-11-060
Head 1365-36-310
Shell 1217-32-052
Liner 1221-36-052
2019 ASP $4,619

Polarstem, oxinium head, Reflection & XLPE linerSNN
Stem 7510-0464
Head 7134-3600
Shell 7133-5552
Liner 7133-2752
2019 ASP $4,537

Top 5 Coated Stem, Metal on Poly Constructs

Market Share (cases) 2019 ORN



Corail stem, Pinnacle Gription shell, AltrX liner DPY
Stem 3L93711
Head 1365-51-000
Shell 1217-32-052
Liner 1221-36-052
2019 ASP $4,266

Accolade II 36mm metal head, Trident shell, X3 liner SYK
Stem 6721-0535
Head 6260-9-136
Shell 702-04-52E
Liner 623-00-36E
2019 ASP $4,380

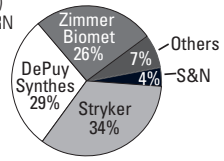
Taperloc 133 HO stem G7 shell and liner ZBH
Stem 51-103120
Head 11-363662
Shell 010000662
Liner 010000739
2019 ASP $4,083

Actis stem, 36mm head, Pinnacle shell, AltrX liner DPY
Stem 1010-11-040
Head 1365-51-000
Shell 1217-22-052
Liner 1221-36-452
2019 ASP $4,235

Summit stem, 36mm head, Pinnacle shell w/Gription, AltrX liner DPY
Stem 1570-01-120
Head 1365-50-000
Shell 1217-32-052
Liner 1221-36-052
2019 ASP $4,317

Top 4 Bipolar Partial Hips

Market Share (cases) 2019 ORN



Accolade II, Lfit V40 head, UHR bipolar cup SYK
Stem 6720-0535
Head 6260-9-126
Bipolar UH1-46-26
2019 ASP $3,006

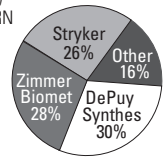
Summit DPY
Stem 1570-01-110
Head 1365-11-000
Bipolar 1035-46-000
2019 ASP $2,449

Corail DPY
Stem 3L92502
Head 1365-11-000
Bipolar 1035-45-000
2019 ASP $2,940

Taperloc ZBH
Stem 51-103110
Head 163662
Bipolar 11-165214
2019 ASP $3,079

Top 6 Unipolar Constructs

Market Share (cases) 2019 ORN



Summit DPY
Stem 1570-03-090
Head 1363-46-000
2019 ASP $1,869

Accolade II SYK
Stem 6721-0535
Head 6942-5-045
2019 ASP $2,544

Echo FX ZBH
Stem 12-151307
Head 12-139016
2019 ASP $1,869

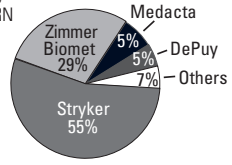
Summit Basic DPY
Stem 1570-06-110
Head 1363-46-000
2019 ASP $1,272

Synergy SNN
Stem 7131-6012
Head 12-6646
2019 ASP $1,800

Versys LD/FX ZBH
Stem 00-7833-012-00
Head 00-7818-046-00
2019 ASP $1,211

Top 3 Mobile Bearing Hip Constructs

Market Share (cases) 2019 ORN



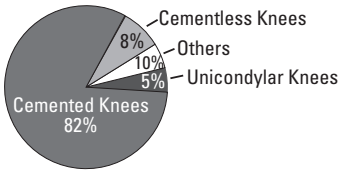
Accolade stem w/ Restoration ADM X3 SYK
Stem 6721-0535
Head 6570-0-128
Shell 702-04-52E
Poly Liner 1236-2-848
CoCr Liner 626-00-42E
2019 ASP $4,317

Taperloc 133 HA, G7 shell, Active Articulation liner ZBH
Stem 51-104110
Head 650-1055
Shell 1100-10244
MOB liner 1100-2446
Liner EP-200150
2019 ASP $7,936

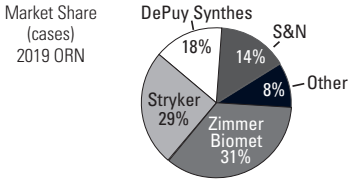
Secur-Fit stem, Trident shell, Restoration ADM SYK
Stem 6054-0915S
Head 18-28-3
Shell 702-04-52E
Liner 1236-2-848
CoCr liner 626-00-42E
2019 ASP $5,472

The 2020 U.S. Knee Implant Price Comparison

CONSTRUCTS OF PRIMARY KNEES



Top 6 Uncoated Femur/Uncoated Tibia Constructs



Triathlon PS femur, tibia, X3 insert and patella **SYK**

Femur	5515-F-402
Tibia	5520-B-400
Insert	5531-G-409
Patella	5551-G-320
2019 ASP	**$3,427**

Persona PS **ZBH**

Femur	42-5026-066-02
Tibia	42-5320-071-02
Insert	42-5221-008-10
Patella	42-5400-000-32
2019 ASP	**$3,910**

Attune PS Fixed Bearing **DPY**

Femur	1504-10-107
Tibia	1506-70-004
Insert PS	1516-40-605
Patella	1518-20-035
2019 ASP	**$3,838**

Vanguard CR femur, I-Beam tibial tray **ZBH**

Femur	183006
Tib	141233
Insert	183440
Patella	184764
2019 ASP	**$3,427**

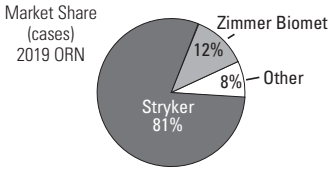
Genesis II Oxinium, PS Hi-flex insert **SNN**

Femur	7142-1225
Tib	7142-0164
Insert	7145-3121
Patella	7142-1035
2019 ASP	**$3,930**

Journey II Oxinium, PS Hi-flex insert **SNN**

Femur	7402-2125
Tib	7402-2214
Insert	7102-7231
Patella	7193-2912
2019 ASP	**$3,928**

Top 2 Cementless Knee Constructs



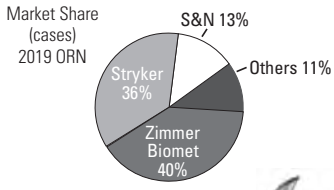
Triathlon **SYK**

Femur	5517-F-402
Tibia	5536-B-400
Insert	5531-G-409
Patella	5551-L-320
2019 ASP	**$4,578**

Persona **ZBH**

Femur	42-5028-070-02
Tibia	42-5300-071-02
Insert	42-5221-009-10
Patella	00-5878-065-32
2019 ASP	**$5,153**

Top 4 Unicondylar Knee Constructs



Restoris MCK **SYK**

Femur	180503
Tib	180614
Insert	180734-1
2019 ASP	**$3,270**

Oxford **ZBH**

Femur	161469
Tib	154722
Insert	159548
2019 ASP	**$3,932**

Persona **ZBH**

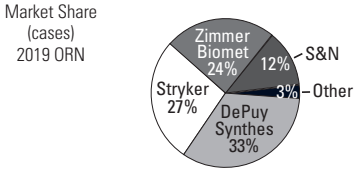
Femur	
Tib	
Insert	
2019 ASP	**$3,458**

ZUK **SNN**

Femur	00-5842-014-02
Tib	00-5842-003-01
Insert	00-5842-024-08
2019 ASP	**$3,404**

CONSTRUCTS OF REVISION KNEES

Top 4 Revision Knee Constructs



Triathlon TS **SYK**

Femur	5512-F-402
Tibia	5521-B-300
Insert	5537-G-413
Patella	5551-G-320
Augment	5543-A-400
Stem fluted	5560-S-112
2019 ASP	**$10,560**

Sigma TC3 **DPY**

Femur	96-0088
Tibia	1294-35-130
Insert	96-2351
Patella	96-0101
Wedge	96-0866
Fluted stem	86-7414
2019 ASP	**$14,066**

Attune **DPY**

Femur	1504-40-106
Tibia	1506-60-004
Insert	1517-10-610
Patella	1518-20-035
Wedge	1549-05-001
Stem	1513-16-060
2019 ASP	**$15,787**

NexGen LCCK **ZBH**

Femur	00-5994-015-92
Tibia	00-5980-037-01
Insert	00-5994-032-10
Patella	00-5972-065-32
Wedge	00-5990-035-10
Stem	00-5988-012-15
2019 ASP	**$11,154**

The constructs and components are those reported through the ORN (Orthopedic Research Network), 2019 edition.

The "ASP" (average selling price) is the average price for each of the components found in "Find-a-Part" at www.OrthopedicNetworkNews.com. The ASPs were obtained from the 2019 ORN.

Since there are literally thousands of combinations of parts for each of the constructs, the parts selected for each of the constructs shown here are the most frequently used ones for each manufacturer/construct combination in the ORN.

*As such, the components selected may not make sense clinically. The classification of hip and knee implant components uses the GIC® classification and the constructs are the orthopedic constructs ®developed by **Orthopedic Network News**.*

For the most recent pricing and construct information, consult www.OrthopedicNetworkNews.com.

Abbreviations:

ZBH:	*Zimmer Biomet*
DPY:	*DePuy Synthes*
SNN:	*Smith & Nephew*
SYK:	*Stryker*

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Partial Hips

Bipolar hips as a percentage of the constructs for partial hips increased from between 64% of the partial hip cases in 2017 to 69% of the cases in 2015. In 2019, 66% of the cases were bipolar constructs. The modular endoprotheses mirrored the bipolar constructs varying from 30% to 36% of the cases. In 2019, 35% of the cases were modular endoprostheses. The average selling price of a bipolar hip with a coated stem was $3,274 in 2019, down 7.4% from 2018. The bipolar hip with an uncoated stem was $2,520 in 2019, down 8.1% from 2018. The weighted average of modular endoprostheses with and without coated hip stems was $2,472 in 2019, down 11.4% from 2018.

Of the individual components used in partial, bipolar heads accounted for 65% of the heads in 2019, followed by unipolar heads at 35%. The bipolar heads averaged $526 per component in 2019, down 19% from 2018, and the unipolar heads averaged $362 in 2019, down 12% from 2018.

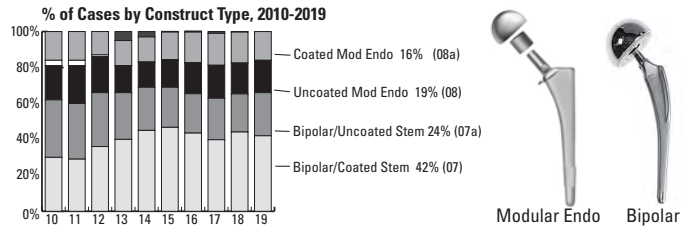
Revision Hips

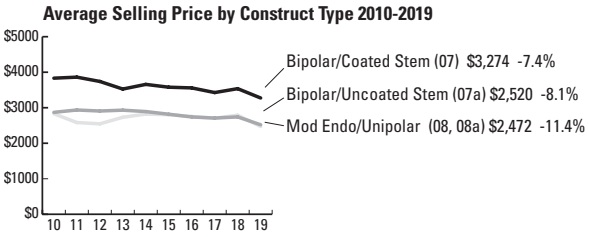
About 16.4% of the total hip and revision hip procedures in the ORN in 2019 were revision hip procedures. This statistic is referred to as the "revision burden" and is compared in many international registries as the revisions cases divided by primary plus revision procedures. However, recent studies have indicated that the concept of what a "revision surgery" is varies from country to country and implant registry to implant registry. For example, should an incision and drainage of a knee be considered a revision? In some countries, it is; in others, it is not.

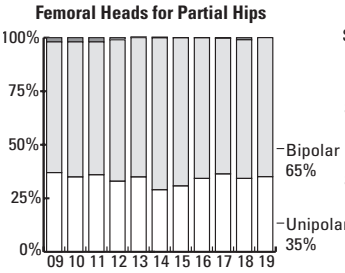
The share of revision hip cases in the 2019 ORN was led by Zimmer Biomet with 33%, followed by Stryker with 28%, DePuy Synthes with 26%, Smith & Nephew with 7% and "Other" with 5% of the cases. Other includes Microport, MedActa, Consensus Orthopedics, among others.

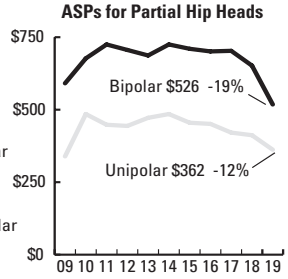
Femoral stems used in revision cases are divided by ONN into one-piece stems, separate proximal body and distal stem combinations, and temporary femurs used in two-stage revisions. Since 2003, there has been a trend away from one-piece stems which accounted for 67% of the stems in 2004 to 24% in 2018. However, beginning in 2018, there has been a gradual increase of one-piece revision stems to 32% in 2019. Other modular systems such as Microport's ProFemur and the SROM accounted for less than 1% of the femoral stems and are not reported separately. Temporary stems used in two-stage revisions which were 10% of the revision stems in 2019, decreased from 12% in 2018.

Trends in Partial Hip Implant Construct Type, 2010-2019

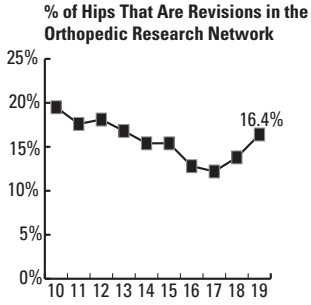


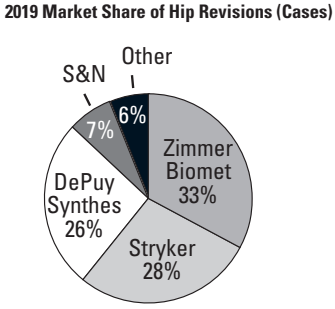


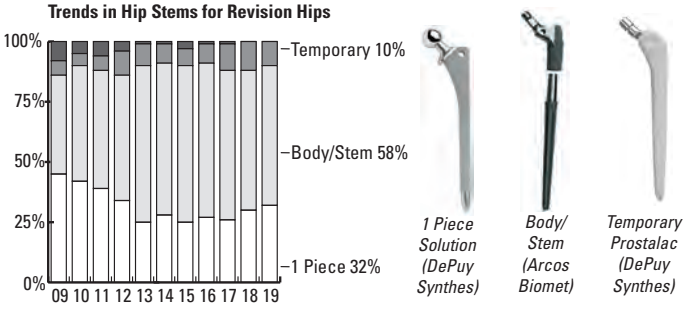


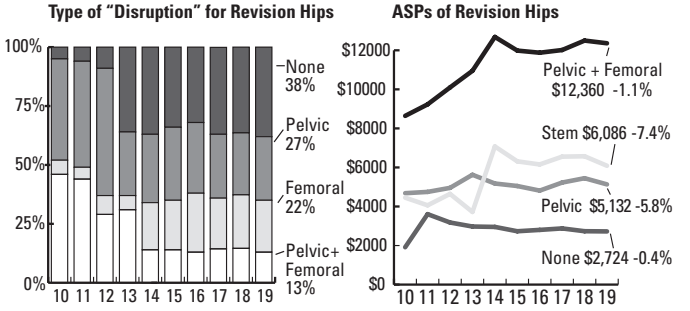


Revision Hips, ORN, 2010-2019









Source: ORN

ONN classifies revision hips into categories based on the disruption to the bone structures. In 2019, the most frequent hip revisions were for cases with no disruption to the femur or the acetabulum exemplified by a head or liner exchange. These accounted for 38% of the cases in the 2019 ORN. Pelvic disruption revisions accounted for 27% of the cases, and revisions with disruptions to the femur accounted for 22% of the cases. The remaining 13% of the cases involved both the femur and the cup. At one extreme, revisions that involved femoral and pelvic disruptions cost ORN members an average of $12,360—at the other extreme, components which did not interfere with the metal-bone interface cost around $2,724 in 2019.

Knee Implants

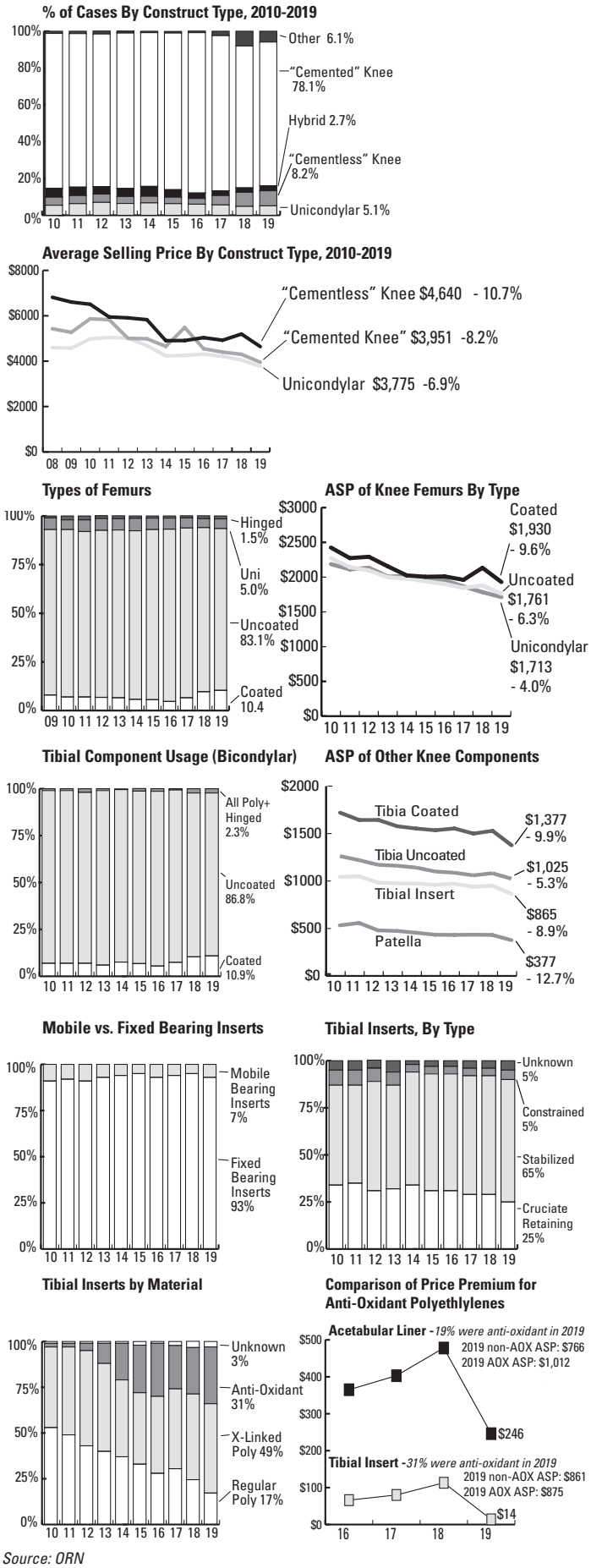
Of the different types of constructs, knee replacements have favored uncoated femur and tibial combinations ("cemented" knees") with 78% of the procedures receiving this construct in 2019. The big story here is the expansion of the coated femur/coated tibia construct. Stryker, among others, are marketing their "cementless" knee systems which are reflected in the growth of the coated knee systems from 3.1% of the cases in 2016 to 8.2% in 2019. The hybrid cases, i.e. those with a coated femur and an uncoated tibia accounted for 2.7% of the procedures in 2019, and the unicondylar procedures accounted for about 5.1% of the total number of knee procedures in 2019.

The implant costs per procedure of knee implants in 2019 varied from unicondylar knees at $3,775 per procedure, to $4,640 for a coated femur/tibial ("cementless") construct.

Femoral components for knee replacements in 2019 were largely uncoated (83.1%), followed by coated (10.4%), unicondylar (5.0%), and hinged (1.5%). Average ASPs in 2019 ranged from $1,930 for a coated femur, $1,713 for a unicondylar femur, and $1,761 for an uncoated bicondylar knee femur.

Tibial components used in bicondylar knees in 2019 were largely uncoated (86.8%), followed by coated implants (10.9%), and all poly tibias or hinged tibias (2.3%). ASPs for coated tibias in 2019 were $1,377 (down 9.9%), and $1,025 for uncoated tibias (down 5.3%). Tibial inserts decreased 8.9% from 2018 to 2019 to $865. Mobile bearing inserts have declined from 12% of the inserts in 2007 to 7% in 2019. Over 65% of the tibial inserts had some sort of stabilization (posterior or cruciate), while 25% were cruciate retaining, and 5% were constrained. In the ORN sample, anti-oxidant tibial inserts accounted for 31% of the inserts in 2019, up from 25% in 2018. There was a greater usage of anti-oxidant polys in knees (31%) vs. hips (19%), although the price premium for anti-oxidant polys in hips was greater than in knees. An anti-oxidant poly tibial insert costs $875 vs. $861 for the non-anti-oxidant, a $14 difference. In hips the difference was $766 for a non-anti-oxidant poly liner vs. $1,012 for the anti-oxidant version, a $246 premium.

Total Knees Key Factors, 2010-2019



Source: ORN

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Bone Cement Use in Total Knees

The use of bone cement in primary knees, identified as construct 24 (uncoated knee femur/uncoated tibia) was investigated in the ORN. This group included 16,000-30,000 cases annually. Among the issues is how many 40g packets are used during the procedure, and whether antibiotic bone cement is used. Each 40g packet of non-antibiotic bone has an 2019 average selling price of about $56 and manufacturer-provided antibiotic bone cement costs three to four times as much.

According to the ORN, there was little difference between the cement profiles between 2018 and 2019 for cemented knees: 41% of the knees used a single unit of bone cement and 56% used 2 units, and 3% used more than 2 units. Forty-three percent of the bone cement units were antibiotic bone cement. Note that this applies to a subset of the hospitals that report bone cement on each of their cases. The analysis does not include the amount of antibiotic bone cement that is a result of hospital based compounding of vancomycin along with standard bone cement. This has been reported as a way to both reduce costs and provide the benefit of antibiotic bone cement, which is ostensibly to reduce infections.

Bone Cement Used in "Cementless" Knees

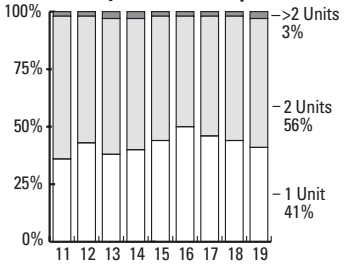
The promotion of "cementless" knees has included economic arguments, (along with the clinical ones of improved patient outcomes), that cementless knees will decrease operating room time and overall costs by eliminating the extra step of preparing and deploying bone cement. *Orthopedic Network News* reached back into its archives to 1991 to determine the number of "cementless" knee cases that actually had used bone cement, negating the economic argument. Although the number of cases prior to 2000 were relatively small, the percentage of "cementless" knee cases with bone cement varied from 0% some years to over 60% in other years. Since 2015, the percentage has hovered between 15 and 20% of the cementless cases. A further review indicated that the decision to use bone cement is specific to each hospital—in 2020, most of the 169 hospital reporting cementless knee had none, however two hospitals reported 100% of their cementless knee cases with bone cement.

Tibial Stems Used in Primary Knees

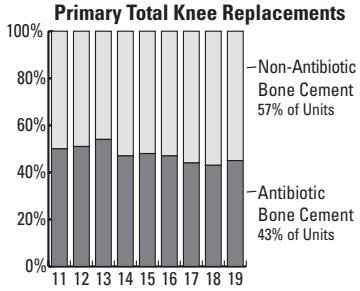
Tibial extension stems have been used extensively in revision surgery in which a tibial base plate is removed and an extension stem is attached to a revision tibia to provide greater stability. A study in the April 2018 issue *Orthopedic Network News* documented the extensive use of tibial extension stems in primary knees. The cost of these extension stems is not trivial—the cost averaged $576 in the 2019 ORN and the percentage of primary knee cases receiving an extension stem increased from 5.4% of the cases in 2012 to 10.6% in 2019.

Bone Cement Usage in Primary Knee Replacement

Units of 40g Bone Cement Used in Primary Total Knee Replacements



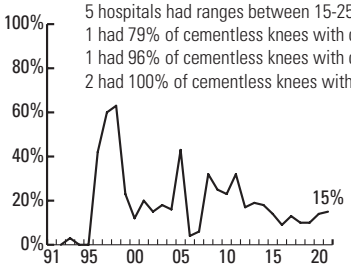
Antibiotic Bone Cement Used in Primary Total Knee Replacements



% of Porous or "Non-Cemented" Knees that Actually Used Cement

% of Cementless Knees with Cement (2020):

5 hospitals had ranges between 15-25%
1 had 79% of cementless knees with cement
1 had 96% of cementless knees with cement
2 had 100% of cementless knees with cement

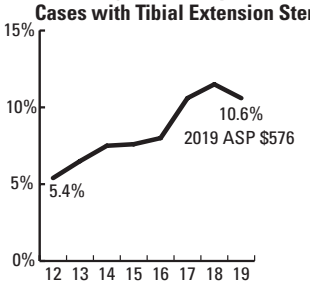


Explanted porous coated tibial baseplate with bone cement

Source: ORN ; Includes 23,231 cases between 1991 and 2020. There were less than 100 cases per year between 1991 and 1998; 100-999 cases between 1999 and 2006 and 2016; 1000-2000 cases between 2007 and 2018, 3095 cases in 2019 and 1356 in Q1-2020.

Tibial Stem Extensions in Primary Knee Replacement

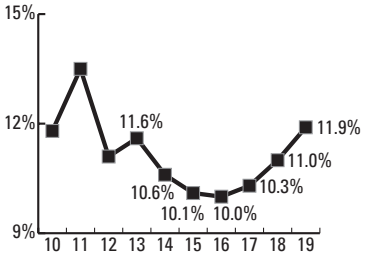
Percentage of Primary Knee Cases with Tibial Extension Stem



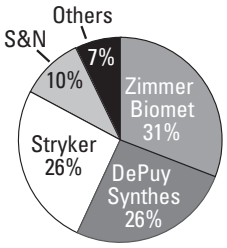
Example of Tibial Extension Stem and Implanted Extension Stem

Revision Knee Procedures and Market Shares (2019)

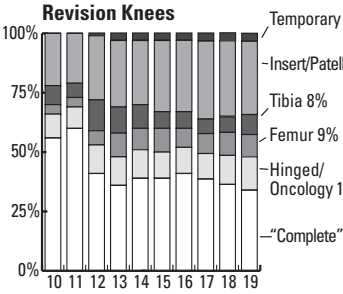
% of Knees that are Revisions in the Orthopedic Research Network



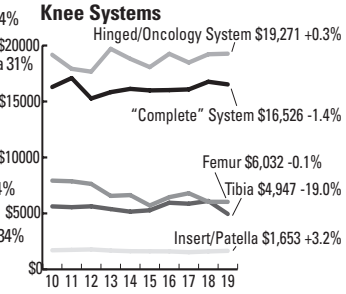
2018 ORN Share of Knee Revisions (Cases)



Trends in Components Used for Revision Knees



Average Implant Costs for Revision Knee Systems



Source: ORN

Revision Knees

It should be stated that "revision knees" are inferred from the data sources provided to *Orthopedic Network News*, which are mostly purchase orders. Some cases may include multiple purchase orders which may look like a revision knee. Where possible these have been excluded from this analysis.

There were 10,547 revision knees in the 2019 ORN (compared to 6,690 in the 2018 ORN). Revision knees as a percentage of all knees were 11.9% in 2019, up from 11.0% in 2018. The largest market share of manufacturers of knee revision systems in the ORN in 2019 was Zimmer Biomet (31%) followed by DePuy Synthes (26%), Stryker (26%), Smith & Nephew (10%), and others (7%).

Orthopedic Network News classifies knee revisions based on the disruption to the major bones involved: femur and/or tibia. That is, some revisions require a removal and replacement of the femoral component, others require removal/replacement of the tibial component, and some, such as a tibial insert or patellar exchange, disrupts neither femur nor tibia. ONN also includes the OSS and Finn of Biomet, the GMRS and MRH from Stryker, the NexGen RHK and MOST from Zimmer, and the Noiles from DePuy as hinged/oncology systems. ONN classifies the Vanguard SSK, NexGen LCCK, TC3, Scorpio TS, Triathlon TS as "complete" systems. They may be used in revision or primary procedures.

Based on a review of the 2019 ORN revision knees, the largest number of revisions were for replacements of "complete" systems, which accounted for 34% of the cases. Following complete systems were replacements of an insert/patella, which accounted for 31% of the revisions, hinged/oncology systems (14%), femoral disruptions (9%), and tibial disruptions (8%). The most expensive systems used for knee revisions in the 2019 ORN were those designated as hinged/oncology systems ($19,271), "complete" systems ($16,526), those with femoral disruptions ($6,032), and tibial disruptions ($4,947). "Temporary" implants, i.e. those used in two-stage revision procedures averaged $3,108 per case. Those requiring a replacement of either a tibial insert or patella averaged $1,653 for implant components per case. Note that these costs include the costs for bone grafts and substitutes.

As was reported in previous years, the implant costs for a revision knee are almost twice as expensive as those for a revision hip—$11,247 vs. $5,730. Given that the revision knees often involve infection and treatment with two-stage procedures, it is logical that increased infection-control vigilance be applied for knee procedures, not only for patient safety issues, but also economic ones.

Data Sources and Methods

In 2019, all of the cases reported in this analysis came from data submitted through either Curvo Labs or through services of Mendenhall, Associates, Inc. Most of the data are derived from purchase orders submitted by the hospitals to the manufacturers of orthopedic implants or related suppliers. Since data are obtained from purchase requisitions, a hospital's method of purchasing implants may mask what is happening to a patient. For example, a total hip case may include a purchase order for a femoral stem and one for an acetabular cup, which may look like two revision cases, one to replace the stem, and one to replace the cup. All attempts are made to identify these cases and exclude them from the analyses.

Average selling prices (ASPs) are calculated from hospitals submitting detail pricing information. Average selling prices for components in "cap" constructs were calculated based on allocating the total cap prices to components based on the ratio of the list price of the component to the total cap price. ASPs for both components and constructs are calculated.

Data from the current year (i.e. 2019) is updated quarterly, since data is received from hospitals on an ongoing basis which is reported in a variety of products and services including OrthoTrends, Market Research Interactive, and Find-a-Part ASPs.

There are two files derived from the quarterly update:
(1) Cases: These are the case-level specific information that is used to calculate average selling price by procedure, construct, percentage of cases with bone cement, etc.
(2) Parts: These are the component level data for each part with a sales, hospital usage, and an average selling price.

Number of cases and parts used for reporting this newsletter:

ORN Cases

	Hips *	Knees **	Hospitals
2018	45,806	64,410	245
2019	62,297	87,405	311

Parts for the ORN Cases ***

	Hips	Knees
2018	247,092	370,499
2019	351,481	560,229

** Hips include total hips (THA), partial hips, revision hips, resurfacing hips.*
*** Knees include total knees (TKA), unicondylar knees, patellofemoral joint replacements, revision knees*
****Parts include the "hardware" (i.e. femurs, femoral heads, shells, liners, inserts, stems, wedges), as well as bone grafts, bone substitutes, bone cements, and non-implantable devices such as cutting guides.) Some hospitals provide information on these extra components and others do not.*

Although this may be the largest detailed sample of hip and knee implant cases, these hospitals are self-selected, that is, no claim is made that they are nationally-representative, although informal surveys indicate that the experience with this group is reflective of many national trends.

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Robotics in Joint Replacements—a 2020 Update

Robotic surgery (or digital assisted surgery) is much more widespread outside of orthopedics than it is in orthopedics. Da Vinci robots are widely used for any surgery involving the soft tissues of the abdomen. There is real-time guidance for cardiac and neurosurgery. More recently, many spinal implant companies have embraced robotic surgery, with NuVasive's announcement of Pulse, Globus Medical's Excelsius GPS, and Medtronic's acquisition of the Mazor robot for spine surgery.

All of these surgeries involve a fairly high level of risk to the patient as well as immediate feedback on if something has not worked correctly. Having a robot to mitigate potential disasters can be reassuring to both patient, surgeon, and hospital. In contrast, although joint surgery can and does go immediately wrong, often the results of a poorly perfomed joint replacement will not be known for months or even years.

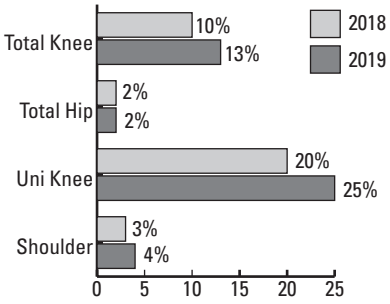
Nevertheless, industry meetings and company investments have tilted toward robots and digital feedback as the next growth area. This is, in part, because the traditional areas of improvement—implant design, materials, and instruments—have largely been mined. In addition, most everything in everyday life has migrated toward the digital (digital socks anyone?), and being stuck in an analog world is an invitation to being perceived as obsolete.

In analyzing the types of digital assistance available, *Orthopedic Network News* has chosen to focus on digital assistance, which incorporates not only robotics, but instruments used for soft tissue balancing, custom cutting guides, and custom made implants and instruments. There are two reasons for this: (1) the use of one of these devices seem to preclude others on any one particular case. In an analysis of over 10,000 knee cases with any digital assistance in the 2019 ORN, fewer than 100 employed more than one digital technique, that is, most were either robot or cutting guide or soft tissue or custom implant. (The bulk of the multiple-digital cases were those used in conjunctions with ConforMIS or Zimmer Biomet custom implants.) So understanding the cost-effectiveness and outcomes of the competing technologies should help drive the decisions in their acquisition. The second reason is that as the manufacturers of these devices gain acceptance in one specialty—unicondylar knees, for example, it is often a matter of time where they will be deployed for others, such as total hips or even spinal fusions.

Types of Total Joint Replacement Digital Assistance

Type	Functions	Examples
Robot/CAS/ Navigation	Provides visual guidance for removing bone/tissue under surgeon supervision	Mako (Stryker) Navio (SNN) ROSA (ZBH) Exactech GPS OMNIBiotics
Custom Implants	Manufactures implant based on patient specific anatomy	ConforMIS Patient Matched Implants (ZBH)
Custom Cutting Guides	Provides disposable cutting guides based on patient specific anatomy	TruMatch (DePuy) Signature, PSI (ZBH) Visionaire (SNN) MyKnee (Medacta)
Soft Tissue Balancing Devices	Provides feedback on balance of soft tissues during knee replacement	Verasense OrthAlign iAssist (ZBH)

Which Joint Procedures are Digital Assistance Used In?



Source 2018-2019 ORN, 97,407 cases in 2018 and 158,626 cases in 2019. Digitally assisted cases were 6,782 cases in 2018 and 13,684 in 2019.

Most Frequently Reported Digital Assist Devices, 2019

Device	Supplier	Description	Hip	Knee	UKA	Shoulder
Mako	Stryker	Robot	1,156	4,801	924	
Navio	SNN	Robot	87	155		
ROSA/CAS	ZBH	Robot	26	895		1
Exactech GPS	Exactech	Robot		21		303
OmniBotics	Corin/OMNI	Robot		21		
Navitracker	ZBH	Robot	26	24		1
ConforMIS	CMIS	Custom implants	24	718	17	
Zimmer Custom	ZBH	Custom implants	12	359	3	
Visionaire	SNN	Cutting guide		1,298	10	
Signature	ZBH	Cutting guide	17	672	47	344
TruMatch	DPY	Cutting guide		205		58
PSI	ZBH	Cutting guide	9	365	1	15
MyKnee	DJO	Cutting guide		144		
OrthoAlign	OrthoAlign	Soft tissue balance		271	4	
Verasense	OrthoSensor	Soft tissue balance		506		
i Assist	ZBH	Soft tissue balance		159		
Cases w/any digital assistance			**1,270**	**10,546**	**1,161**	**722**
			9%	**78%**	**8%**	**5%**

Source 2019 ORN. ZBH=Zimmer Biomet, SNN=Smith & Nephew, DPY=DePuy Synthes, CMIS=ConforMIS. UKA=Unicondylar knee. "Knee" includes bilateral knees, excludes knee revisions. "Hip" includes bilateral hips, excludes knee revisions. Not shown are 1,618 cases where procedure was different or could not be determined.

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Although the percentage of cases with digital assistance has increased between 2018 and 2019, it is relatively small. About 2% of total hips used digital assistance in both 2018 and 2019, and shoulder replacements increased from 3% of cases in 2018 to 4% in 2019. In contrast, total knee replacements increased from 10% using digital assistance in 2018 to 13% in 2019, while unicondylar knees increased from 20% of cases in 2018 to 25% in 2019. Since indirect markers are used for these estimates, it is possible that the percentage of cases is higher than shown.

The table on the bottom of page 18 are the devices known by this publication to involve digital assistance as of the end of 2019. Some of the products must be inferred from supplies or disposable products used in conjunction with the robot. For example, the Zimmer Biomet ROSA doesn't have any disposable items that are labelled as "ROSA" products, however, most of the cases had a guiding pin manufactured by Orthosoft called CAS which would be used to guide the ROSA robot. From an analysis of the number of cases that used digital assistance, 86% involved total knees or unicondylar knees. followed by hips with 9% and shoulders with 5%. Interesting is the concentration in the ORN for shoulder replacements to have digital assistance from Zimmer Biomet's Signature custom cutting guides, and Exactech GPS' robot.

Determining Market Shares

Robotic assistance in joint replacement is notoriously difficult to monitor because of the different levels of adoption, intervention, and abandonment each of the technologies have. For example, most of the industry watchers point to "installed platforms," a metric that emphasizes the sale of multi-million dollar equipment which bolster the companies financial statements. The degree to which a robot is used on a specific surgery is largely unknown. It is imperative that hospitals who have or are considering acquiring a robot determine not only the best financial terms and conditions, but also the method of digitally identifying its use in surgery. This is the only way they will intelligently be able to determine if the robot is acting as anything more than an expensive dust collector in the operating room suites.

Caveats on Market Shares

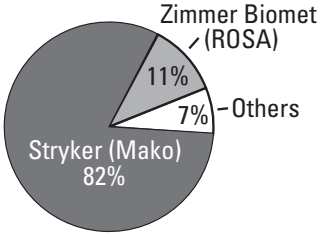
Data for this article was taken from the 2019 Orthopedic Research Network (ORN), which obtained purchase orders and some case information from about 334 hospitals in 2019. Digital assistive devices are often purchased as capital items or through bulk purchases, which are not attached to a specific case. Even if a robot is identified through the unique disposables used on the case, there is no understanding of the degree to which a robot was used in completing the surgical procedure.

As such, the estimates presented here are our "best guesses" on the volume of cases, using of products and shares for the different types of devices based on the purchase orders we receive.

Robots Used in Joint Replacements

Mako (Stryker)

Navio (Smith & Nephew)



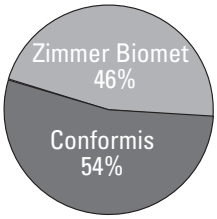
ROSA (Zimmer Biomet)

Source 2019 ORN, 9,047 cases

"Custom" Implants

CONFORMIS

ZIMMER BIOMET

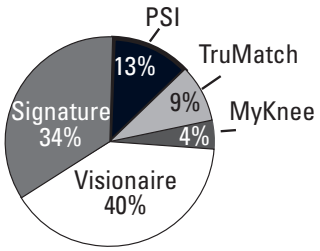


Source 2019 ORN, 1,397 cases

Custom Cutting Guides

Signature (Zimmer Biomet)

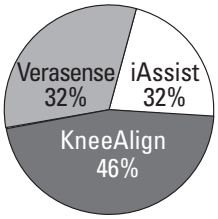
Visionaire (Smith & Nephew)



Source 2019 ORN, 3,290 cases

Soft Tissue Balancing Devices

Verasense (OrthoSensor)



KneeAlign2, HipAlign (OrthAlign)

iAssist (Zimmer Biomet)

Source 2019 ORN, 1,583 cases

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OrthoTrends—2011 - Q1/2020

The data for these OrthoTrends are taken from the Orthopedic Research Network, a quarterly database of purchase and clinic data submitted to Orthopedic Network News and Curvo labs. There were 60,020 cases in Q1/2020 from 164 hospitals for joint replacements, trauma, and spinal fusions. The purchase data includes $356 million in spend. The number of cases and amount of spend will vary from quarter to quarter depending on how data is received by the hospitals submitting. Note that the statistics reported here are often the 2020/Q1 update of those reported on pages 9-17.

Hip Replacements:

Construct Mix: Coated hip stems with either a metal or ceramic head, shell and poly liner accounted for about 85% of the total hips in the ORN in 2020/Q1. The remaining 15% include those with cemented hip stems, mobile bearing hips, resurfacing hips, among others. The average selling price (ASP) of a ceramic-headed system was $4,861 (hardware only was $4,845), up 1% from 2019 and a metal-headed system was $4,536 (hardware only $4,525), no change from 2019.

Femoral Stems: Femoral stems were dominated by coated hip stems which accounted for 84% of the hip stems sold, with an average selling price of $2,025. Uncoated (cemented) hip stems accounted for 12% of stems, and revision/long stems were 4% of the total. The ASPs for uncoated stems were $1,372, and revision/long stems were $7,580.

Femoral Heads: Ceramic femoral heads accounted for 72% of the femoral heads sold through 2020/Q1 in the ORN. These had an ASP of $818 compared to $488 for metal heads. Both categories registered price decreases between 2019 and 2020/Q1.

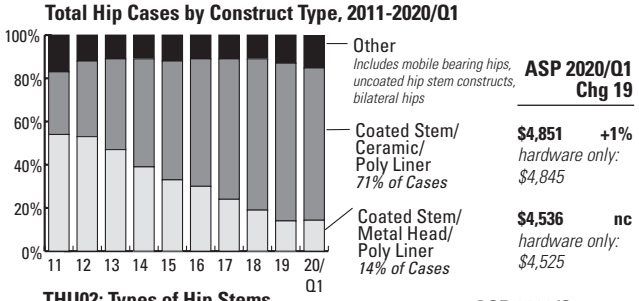
Femoral Head Size: Femoral head sizes gravitated toward 36mm which accounted for 56% of the femoral heads in the ORN in 2020/Q1, with an ASP of $715, down 6% from 2018. Smaller heads cost the least ($639), compared to the 36mm and larger heads ($819).

Acetabular Liners: Anti-oxidant liners accounted for 22% of the acetabular liners in 2020/Q1 compared to 75% for the cross-linked poly liners. Anti-oxidant liners sported an ASP of $932 compared to $737 for cross-linked liners. Anti-oxidant liners appear to be gaining share compared to the older cross-linked polyethylene liners.

Acetabular Shells: Ultraporous shells accounted for 59% of those sold in 2020/Q1 with a price of $1,332 compared to $979 for non-ultra porous shells. Ultraporous shells are designed to increase the surface area for the bone to grow into, thus providing a more secure foundation for the cup in the pelvis.

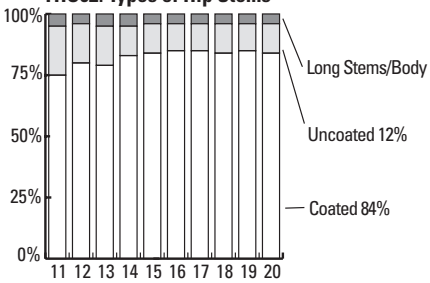
Key Factors in Total Hips, 2011-2020/Q1

Total Hip Cases by Construct Type, 2011-2020/Q1



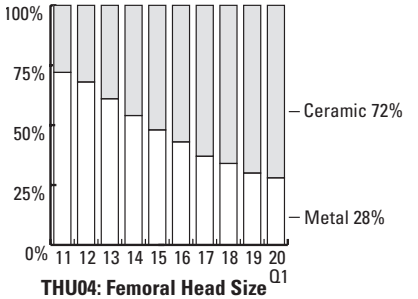
	ASP 2020/Q1	Chg 19
Coated Stem/ Ceramic/ Poly Liner	$4,851	+1%
hardware only:	*$4,845*	
Coated Stem/ Metal Head/ Poly Liner	$4,536	nc
hardware only:	*$4,525*	

THU02: Types of Hip Stems



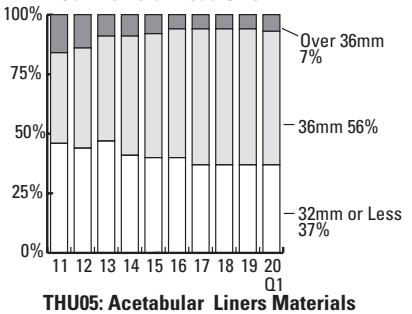
	ASP 2020/Q1	Chg 19
Long Stems/Body 4%	$7,580	+15%
Uncoated 12%	$1,372	+4%
Coated 84%	$2,025	+6%

THU03: Types of Femoral Heads



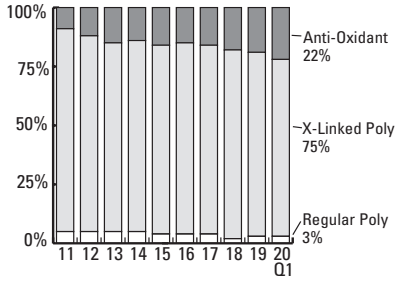
	ASP 2020/Q1	Chg 19
Ceramic 72%	$818	-2%
Metal 28%	$488	-3%

THU04: Femoral Head Size



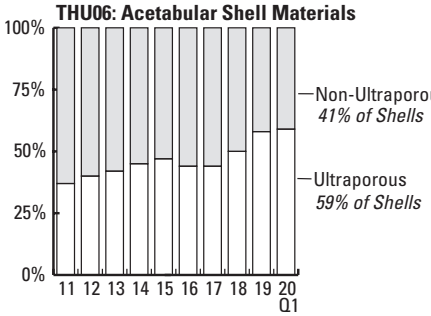
	ASP 2020/Q1	Chg 19
Over 36mm 7%	$819	-7%
36mm 56%	$715	-6%
32mm or Less 37%	$639	-6%

THU05: Acetabular Liners Materials



	ASP 2020/Q1	Chg 19
Anti-Oxidant 22%	$932	-17%
X-Linked Poly 75%	$737	-7%
Regular Poly 3%		

THU06: Acetabular Shell Materials



	ASP 2020/Q1	Chg 19
Non-Ultraporous *41% of Shells*	$979	-2%
Ultraporous *59% of Shells*	$1,332	-3%

Source: All data on this page, Orthopedic Research Network (ORN)

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Acetabular Screws: Acetabular screws are used to augment fixation of acetabular cups. In the 2020/Q1 ORN, 48% of the cases had no screws, 24% had one screw, 21% had two screws, and 7% had more than 2 screws, which averaged $53.

Knee Replacements

Construct Mix: Cementless knees accounted for 10% of the total knees in 2020/Q1 ORN, up from 6% in 2018. Their ASP was $4,708 (hardware $4,684), compared to $4,159 for the cemented knees which accounted for 70% of the total knees. Partial knees accounted for 5% of the cases with an ASP of $3,803.

Tibial Inserts: The most significant differentiation in tibial inserts is the type of polyethylene, although there is not as much difference in costs as there used to be. Anti-oxident polyethylenes accounted for 33% of the tibial inserts in 2020/Q1 ORN with an ASP of $921, compared to cross-linked poly with accounted for 49% of the inserts with an ASP of $899.

Bone Cement: Although bone cement can be used for a variety of orthopedic procedures, the vast majority of bone cement is used in cemented knees. Thirty six percent of the cemented knee cases had a single 40g pack of bone cement; 61% had two, and 2% had more than two packs.The use of antibiotic bone cement has tracked downward since 2011; in the 2020/Q1 ORN, antibiotic bone cement units used on knee replacements accounted for 35% of the units, with an ASP of $181. The decrease in ASP and units is partially attributed to a change in the sample of hospitals in 2020.

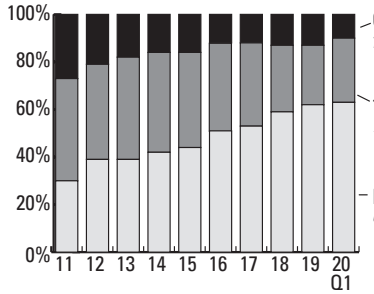
Tibial Extension Stems: Tibial extension stems can add stability to a tibial baseplate, and some, such as Stryker's Triathlon TS or Zimmer's Persona can accommodate either a long extension stem or a simple "cap" on the bottom of the tibia. The use of tibial extension stems in total knees is about 14% of the knee cases in 2020/Q1, with an ASP of $599.

Shoulder Replacements

Construct Mix: Reverse shoulders accounted for about 63% of the shoulder replacements in 2020/Q1 with an ASP of $8,406 compared to $5,757 for a total shoulder. Total shoulders accounted for 27% of the implanted shoulders, and partial shoulders, once the second largest group of shoulders have been relegated to less than 5% of the cases.

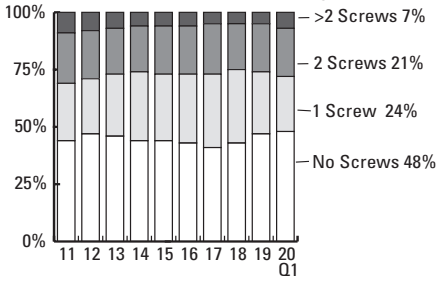
Shoulder Key Factors, 2011-2020/Q1

SHU01: Shoulder Constructs



	ASP 2020/Q1	Chg 19
Total	$5,757	+2%
Reverse	$8,406	+2%

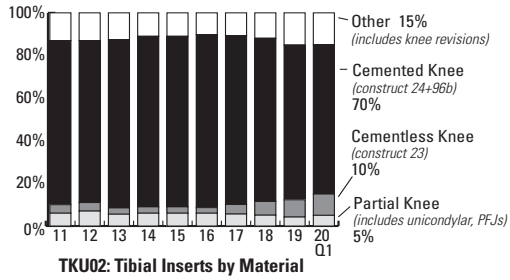
THU07: Acetabular Screw Usage



ASP of Acetabular Screw
2020/Q1 $53

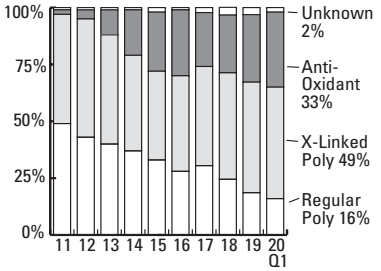
Total Knees Key Factors, 2011-2020/Q1

TKU01: Knee Constructs 2011-2020/Q1



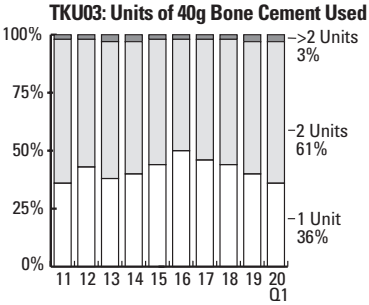
	ASP 2020/Q1	Chg 19
Cemented Knee	$4,159	+2%
hardware only	*$4,035*	
Cementless Knee	$4,708	-1%
hardware only	*$4,684*	
Partial Knee	$3,803	+1%
hardware only	*$3,697*	

TKU02: Tibial Inserts by Material

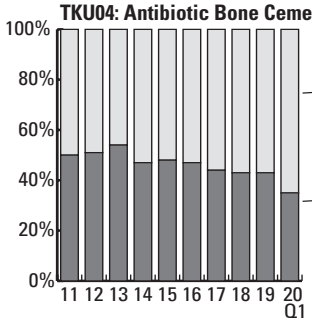


	ASP 2020/Q1	Chg 19
Anti-Oxidant	$921	-2%
X-Linked Poly	$899	nc
Regular Poly	$749	-7%

TKU03: Units of 40g Bone Cement Used in Primary Total Knee Replacements

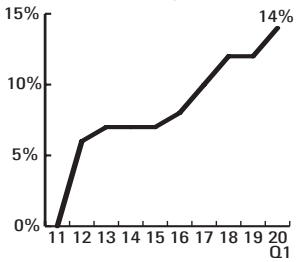


TKU04: Antibiotic Bone Cement in Total Knees



	ASP 2020/Q1	Chg 19
Non Antibiotic Bone Cement	$55	-5%
Antibiotic Bone Cement	181	-13%

TKU05: Primary Knee Cases with Tibial Extension Stem



ASP 2020/Q1	Chg 19
$599	+1%

Example of Tibial Extension Stem and Implanted Extension Stem

Source: Orthopedic Research Network (ORN), 2019-2020
Percentage of cases assigned to construct 24 (Primary cemented knee) with a tibial extension stem for all Curvo and ONN hospitals.

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Lumbar Fusions

Levels Fused: Although 73% of the lumbar fusions involve either one or two levels, the number of cases with more then three levels increased from 10% of the cases in 2010 to 14% in 2020/Q1. The ASP of the cases increase with the number of levels fused from $9,368 for a single level, $13,744 for a two-level fusion, and $15,627 for a three level fusion.

Treatment of Single Level Lumbar Fusions: The most frequent category of treatment for a single level lumbar fusion is a pedicle screw construct with an interbody fusion device, which accounted for 63% of the single level lumbar fusions. This was followed by pedicle screw constructs (23%), and interbody only (11%). Both the interbody plus pedicle screw constructs and the interbody constructs had similar costs per case at $10,466 for the IBF+PS and $9,875 for IBF only, while the pedicle screw only cases were $5,955 per case.

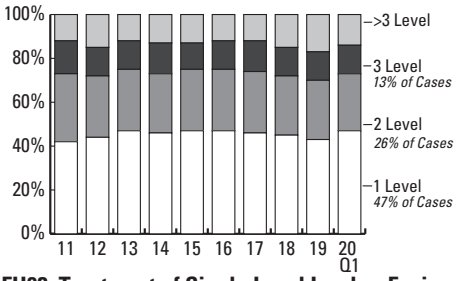
Resources: Metals (rods, plates, and screws) accounted for 33% of the costs of lumbar fusions, followed by biologics with 29%, and interbody fusion devices at 28%. The remaining 10% of costs were for "Other.

Biologics: There are literally hundreds of osteobiologics that are used in spine procedures. Among the most costly are BMP (bone morphogenic protein aka InFuse), and cell-based matrices (e.g. Trinity Elite). Others include variations of demineralized bone matrix, bone substitutes, and allograft bone. In the ORN, BMP usage has declined from 59% of the lumbar fusions in 2010 to 34% in 2020/Q1. Cell-based matrices have increased from 5% of the cases in 2010 to 16% in 2020/Q1, and cases employing both a cell-based matrix and BMP increased from no cases in 2010 to 5% in 2020/Q1. The cost of the BMP/Cell-based matrix combination was $6,505/case, the cell-based matrix alone was $3,798, and the BMP only was $4,075.

There has been some movement in the sizes of BMP that are used in spinal surgery. The smallest sizes averaged about $1,546 in 2020/Q1 and the largest average $5,363. No documentation or guidelines have been provided outlining the size of BMP to be used for fusing lumbar vertebra, so many hospitals have taken to convincing their surgeons to use smaller sizes of BMP in lumbar fusions. In the ORN, the percentage of BMP that were XXSM or XSM was 22% compared to 31% which were small, and 47% where were medium, large, or extra large. The overall cost per purchase averaged $3,817 in 2020/Q1, down 4% from 2019. This implies that ths shift to smaller sizes and lowered pricing has resulted in lower costs.

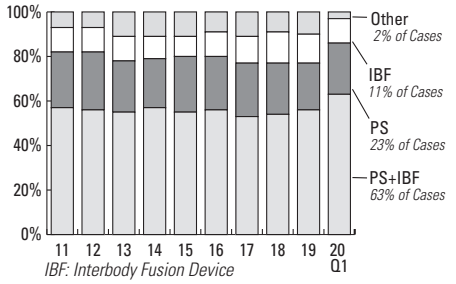
Lumbar Fusions, 2011-2020 Q1

LFU01: Number of Levels Fused in Lumbar Fusions



	ASP 2020/Q1	Chg 19
>3 Level		
3 Level	$15,627	-2%
2 Level	$13,744	+2%
1 Level	$9,368	-10%

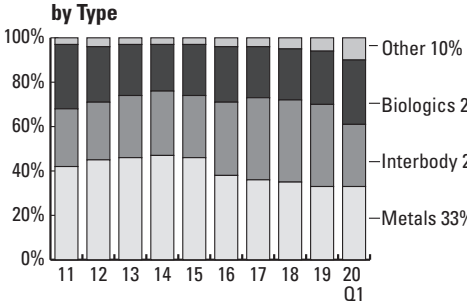
LFU03: Treatment of Single Level Lumbar Fusion



	ASP 2020/Q1	Chg 19
Other		
IBF	$9,875	-12%
PS	$5,955	-5%
PS+IBF	$10,466	-11%

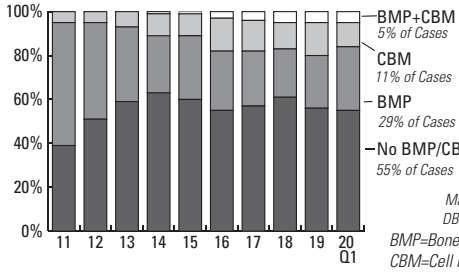
IBF: Interbody Fusion Device
PS: Pedicle Screw Construct
PS+IBF: Pedicle Screw plus Interbody Fusion Device

LFU02: 1-Level Lumbar Fusion Implant $/Case, by Type



	ASP 2020/Q1	Chg 19
Other 10%	$980	+67%
Biologics 29%	$2,684	+6%
Interbody 28%	$2,629	-31%
Metals 33%	$3,055	-11%

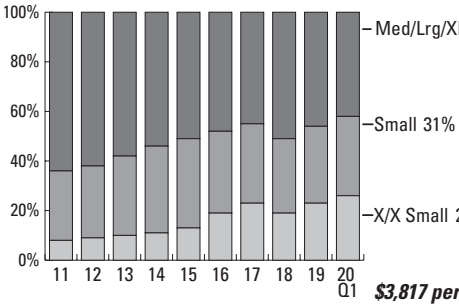
LFU05: Biologics in Lumbar Fusions



	ASP 2020/Q1	Chg 19
BMP+CBM	$6,505	-23%
CBM	$3,798	-12%
BMP	$4,075	-10%
No BMP/CBM	$0	

May have bone substitutes, DBM, or other osteobiologics
BMP=Bone morphogenic protein
CBM=Cell based matrix

OBU01: BMP Size Distribution

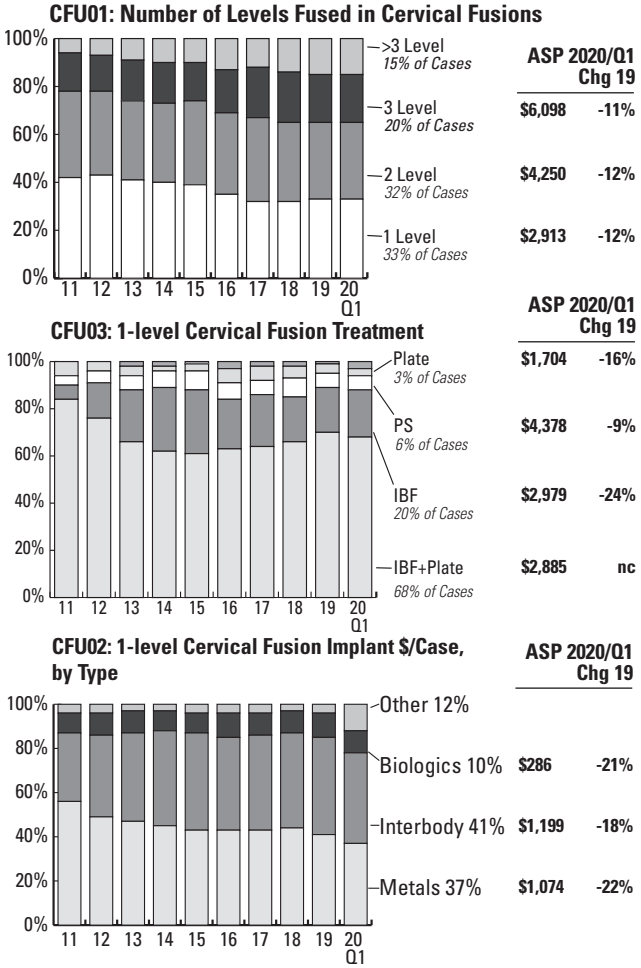


	ASP 2020/Q1	Chg 19
Med/Lrg/XL 47%	$5,363	nc
Small 31%	$3,651	-1%
X/X Small 22%	$1,546	-3%

$3,817 per dose, down 4% from 2019

Cervical Fusions

Cervical Fusions, 2011-2020/Q1

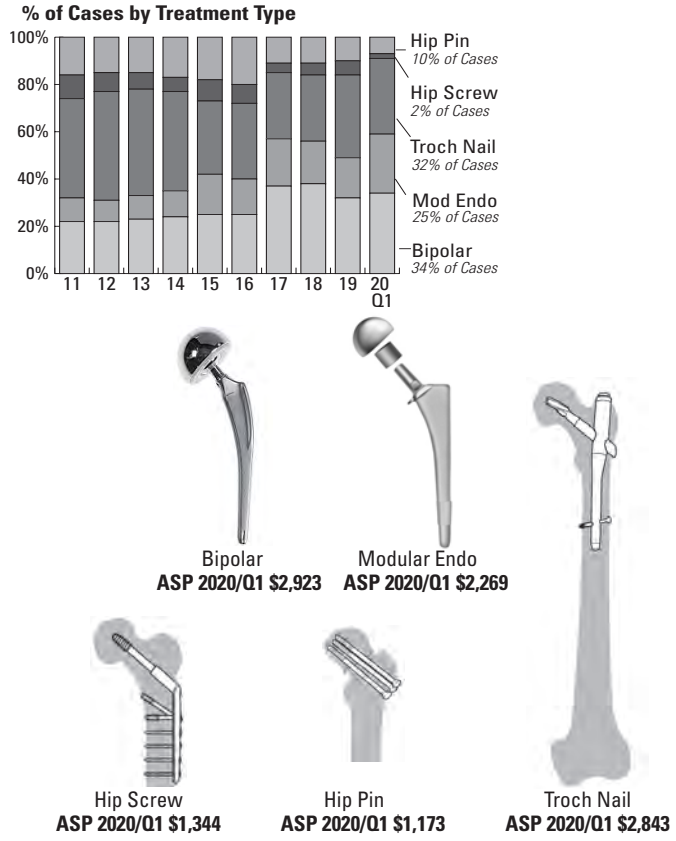


Levels Fused: In contrast to lumbar fusions, the number of multi-level fusions of three or more vertebra of the neck has increased from 20% of the cervical fusion cases in 2010 to 35% in 2020/Q1. The hardware and other costs per case increase accordingly from $2,913 for a single level fusion to $4,250 for a two-level, and $6,098 for a three level fusion.

Treatment: Sixty-eight percent of the single level cervical fusions were treated with a combination of interbody fusion device and a cervical plate. The interbody only cases have increased significantly from 4% of the cases in 2010 to 20% in 2020/Q1.

Resources for Single Level Cervical Fusions: In contrast to lumbar fusions, the most expensive component of the single-level cervical fusions cases were the interbody fusion devices which averaged $1,199, followed by metals with $1,074, osteobiologics at $286 and all other components at $355. The interbody fusion devices accounted for 41% of the resources, while the metals accounted for 37% of total costs.

Trauma Devices, 2011-2020/Q1



Source: All data on this page, Orthopedic Research Network (ORN)

Hip Fracture Treatment: There are a variety of modalities available to treat hip fractures, although treatment will depend on the location of the fracture and available resources. Although it is not possible to definitely say how hip fractures are treated in the hospitals contributing data to the ORN, the modalities listed above are generally used for the treatment of hip fractures. According to the 2020/Q1, the most frequent treatment modality was a bipolar hip which accounted for 34% of the cases. Trochanteric nails accounted for 32% of the cases, modular endoprosthesis constructs accounted for 25% of the cases, followed by hip pins at 7% and hip screws at 2% of cases. The ASPs for the cases were highest with bipolar constructs at $2,923 and lowest with hip pins at $1,173.

About the Sample:
Cases examined in the database for this article:

	CY 2019	Q1 2020	Q1/2020 Hospitals
Total hips	42,045	6,889	149
Total knees	68,977	14,029	154
Shoulders	14,810	2,867	138
Lumbar fusions	33,616	3,317	105
Cervical fusions	22,900	2,136	102
Hip fracture constructs	18,250	2,897	141

Cases are excluded from the analysis if it appears that the data do not reflect bona fide cases.

Trauma

Posted to www.OrthopedicNetworkNews.com on July 28, 2020 at 9:00 AM EDT

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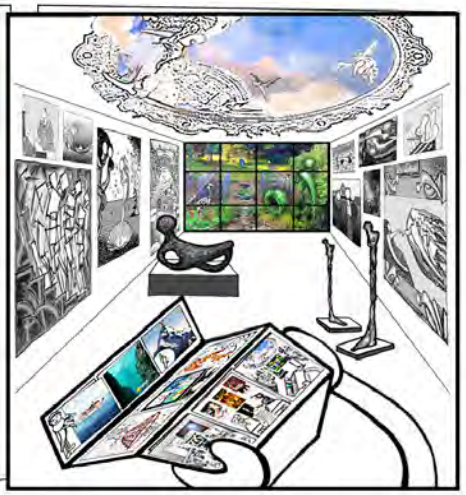
Writing

Museums



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