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ORIGINAL ARTICLE • GENERAL ORTHOPAEDICS - DEVICES

Consolidation and maturation of the orthopaedic medical device market between 1999 and 2015

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Abstract

Orthopaedic surgeons often require highly specialized medical devices, implants, and equipment, which are usually offered by several vendors/companies. This study assesses long-term market trends for orthopaedic medical device companies and examines various implications for healthcare cost. Using S&P Capital IQ, a Wall Street database, financial data were gathered on orthopaedic device companies, ranked by worldwide sales, from 1999 to 2015. Annual sales were aggregated to calculate market share and compounded annual growth rates (CAGRs). Overall, the global orthopaedic device market grew at 12.0% CAGR from 1999 to 2008, before slowing to 2.8% from 2009 to 2015. Between 1999 and 2015, the top 5 companies increased total market share from 52.8 to 62.2%. The orthopaedic device market is not only consolidating under a few dominant players, but also growing at a decreasing rate, both of which signal a maturing industry. These trends are likely to shape patient care and healthcare costs in orthopaedic surgery in years to come.

Keywords Orthopaedics · Medical devices · Market share · Industry growth

Introduction

Innovation in medical technology influences clinical practice and public health [1] and has generally been regarded as a major driver of change in healthcare costs. However, the relationship between technological innovation, clinical impact, and cost is complex. At the smaller scale, the balance between technological innovation and cost-of-care is heavily affected by both the nature of the intervention (e.g., invasive medical devices) and the availability of alternative treatments [2]. However, at the larger scale, technological innovation is related to market competition [3], suggesting that industry business cycles could affect healthcare costs associated with clinical practice.

As interest grows in improving value and decreasing total costs of care, it has become increasingly important to analyze the evolution of medical technology markets [4]. This may be particularly true for high-cost medical specialties—such as orthopaedic surgery—that are heavily reliant on medical technologies. With respect to orthopaedic surgery, increases in rates of activity-related injuries, obesity [5], and an aging population [6] have all been associated with an increased incidence of orthopaedic diseases [7, 8] and demand for surgical interventions. Many orthopaedic procedures, in turn, require specialized medical devices and implants [9], such as joint arthroplasties, plates, screws, and grafts [10].

Historical analysis of the overall global medical device technology market shows that the top 10 companies account

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for approximately 40% of the total market, whereas the top 50 account for 78% of the entire market [11]. However, the orthopaedic medical device market, as a subsector of the global medical device industry, appears to have a greater degree of clustering [11]. Understanding developments in the orthopaedic market would provide important context for ongoing changes in surgical practice and costs [12, 13] and helps to predict the future of orthopaedic care [4, 14]. Yet, the evolution of the orthopaedic device market remains poorly characterized, particularly with respect to key drivers of changing industry dynamics, including mergers and acquisitions (M&A) activity.

The purpose of this study was to address some of these gaps by assessing relevant changes in the orthopaedic devices market over the past two decades. Specifically, this paper sought to assess market trends for the ten highest grossing orthopaedic device companies between 1999 and 2015, including market growth rate, market share, and competition. These data were then analyzed to evaluate their implications for the future of patient care and healthcare cost.

Methods

Data sources

Financial information was gathered on the top 10 orthopaedic companies ranked by worldwide market share, defined as proportion of annual sales. For publicly traded companies, audited financial statements were obtained online through annual filings (Form 10-K) that are registered with the Securities Exchange Commission (SEC) and are accessible to the public via company Web sites or the SEC EDGAR (Electronic Data Gathering, Analysis, and Retrieval) database. For private companies exempt from filing with the SEC, financial data are rarely disclosed to the public. Annual sales were therefore obtained from industry reports, which provide reasonable estimates of financial data for private companies. The primary industry reports used for this study were *Worldwide Orthopaedic Market* annual reports from OrthoWorld (Chagrin Falls, Ohio, USA), the only strategic services firm dedicated to publishing data on the worldwide orthopaedic market. Other data sources included published reports, newsletters, and news abstracts including Orthoknow, US Orthopaedic Product News, and the National Orthopaedic Surgeon Panel series [15].

A list of comprehensive M&A transactions was obtained through Standard & Poor's (S&P) Capital IQ (New York, NY, USA), a financial information database and data analytics platform used widely across Wall Street [16]. This data source was originally designed to serve the investment banking community and is currently used by both financial and academic institutions [17].

Market trends

Worldwide annual sales of each orthopaedic device company were calculated for each year during the period of interest (1999–2015). Since certain companies had reporting segments that did not relate to orthopaedic devices (e.g., Zimmer and Biomet report dental sales), revenue adjustments were made (Supplemental Table 2).

By adding "Other Sales," or sales contributed by companies outside of the ten highest grossing companies, total worldwide sales of orthopaedic devices were estimated (*Orthoworld*). Market share was then calculated as a percentage of the total worldwide market for sales for the highest five and ten grossing companies. If a top 10 company was acquired during a fiscal year, their status was reported and replaced by the next largest orthopaedic device firm. Compounded annual growth rates (CAGR) were calculated to measure average growth over the selected time period [4].

Consolidation

S&P Capital IQ was used to compile all M&A transactions for each company. This was done by using the M&A/Private Placements search engine, as well as the following filters: (1) By Role—Buyer Only; (2) By Type—Merger/Acquisition; (3) By History—All History; and (4) Include Transactions For—Subsidiaries. Transactions of less than $10 million were omitted. The aggregated list was then filtered based on the target company profile, and only transactions where the target company was an orthopaedic device firm were retained. The final list was cross-checked with company-specific filings, press releases, and third-party annual reports (*Orthoworld*).

Results

Market share

Between 1999 and 2015, the five largest orthopaedic device firms by market capitalization have gained market share with respect to the overall worldwide market (Supplemental Table 1). The top 5 companies increased their market share from 52.8 in 1999 to 62.2% in 2015, even as the top 10 companies have ceded market share from 72.7 in 1999 to 70.5% in 2015 (Table 1).

Table 1 Consolidation of top 5 and 10 companies' market share in orthopaedic device market from 1999 to 2015 (*all numbers in $M) and compounded annual growth rate (CAGR) increases at decreasing rate from 1999 to 2015

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total top 5 companies sales	$6153	$6657	$7444	$9610	$11,440	$13,377	$15,132	$16,385	$19,021	$20,794
% Market share	52.8	50.9	50.8	56.1	57.6	58.3	58.5	56.7	58.6	57.6
Total Top 10 companies sales	$8464	$9221	$10,319	$12,679	$15,019	$17,571	$19,760	$21,756	$25,009	$28,038
% Market share	72.7	70.6	70.4	74.1	75.6	76.6	76.4	75.2	77.0	77.7
Other sales	$3180	$3848	$4331	$4437	$4835	$5365	$6094	$7167	$7462	$8052
Total worldwide market	$11,644	$13,069	$14,650	$17,116	$19,854	$22,936	$25,854	$28,923	$32,471	$36,090
YoY market growth (%)		12.2	12.1	16.8	16.0	15.5	12.7	11.9	12.3	11.1

	2009	2010	2011	2012	2013	2014	2015	CAGR 1999–2008	CAGR 2009-2015	CAGR Total
Total top 5 companies sales	$21,810	$22,912	$23,588	$24,763	$26,751	$27,546	$28,527	12.9%	3.9%	10.1%
% Market share	57.5	58.2	56.2	58.3	61.3	61.1	62.2			
Total Top 10 companies sales	$29,011	$30,506	$31,472	$29,944	$32,619	$33,583	$32,335	12.7%	1.6%	8.7%
% Market share	76.5	77.4	75.0	70.5	74.8	74.5	70.5			
Other sales	$8,890	$8890	$10,500	$12,500	$11,000	$11,500	$13,500	9.7%	6.1%	9.5%
Total worldwide market	$37,901	$39,396	$41,972	$42,444	$43,619	$45,083	$45,835	12.0%	2.8%	8.9%
YoY market growth (%)	5.0	3.9	6.5	1.1	2.8	3.4	1.7			

Market growth rate

The overall worldwide orthopaedic device market grew at a compounded annual growth rate (CAGR) of 8.9%, and for the top 5 and 10 companies at a rate of 10.1% and 8.7%. Yet, for the 1999–2008 period, the overall worldwide orthopaedic device market grew at 12.0% (top 5—12.9%, top 10—12.7%), and from 2009 to 2015 grew at 2.8% (top 5—3.9%, top 10—1.6%) (Fig. 1; Table 1). In contrast, the global and US medical device sector—representing 7.9% of worldwide market share [18]—has grown at a CAGR of ~ 4.4% and ~ 6.1%, respectively [19].

M&A

Accelerating consolidation in the orthopaedic device market between top 10 companies

From 1999 to 2015, there was significant M&A activity by top firms (Table 2). Two clusters of orthopaedic firms exist

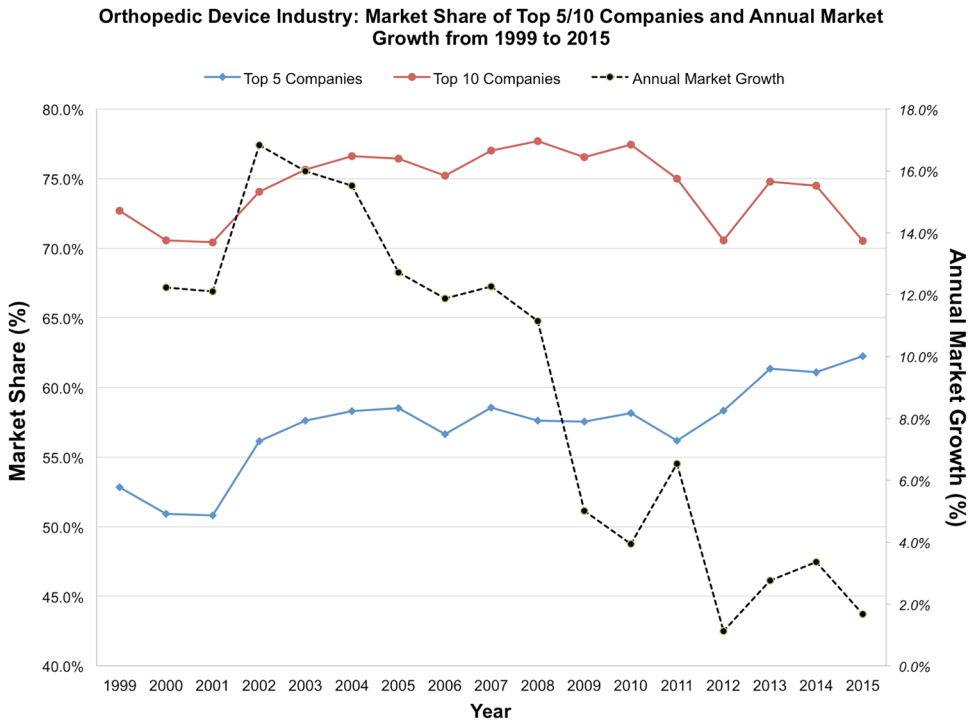

Fig. 1 Orthopaedic device industry: market share from 1999 to 2015

Table 2 Significant M&A transactions in orthopaedic device market from 1998 to 2015

Acquirer	Target	Date	Value (USD Millions)
Sulzer (Centerpulse)	Spine-Tech	Dec 1997	$653
DePuy	AcroMed	Mar 1998	$325
J&J	DePuy	Jul 1998	$3852
Stryker	Howmedica	Aug 1998	$1900
Medtronic	Sofamor Danek	Nov 1998	$3516
Smith & Nephew	Exogen, Inc.	Jul 1999	$61
J&J	Innovasive Devices, Inc.	Nov 1999	$102
Stryker	Image Guided Technologies	Jun 2000	$12
Zimmer	Bioelectron, Inc.	Sep 2000	$90
Smith & Nephew	Orthopaedic BioSystems Ltd., Inc.	Nov 2000	$25
Smith & Nephew	ORATEC Interventions, Inc.	Feb 2002	$290
Stryker	Surgical Dynamics, Inc., Spinal Business	Jun 2002	$135
Medtronic	Spinal Dynamics Corporation	Jun 2002	$270
Stryker	Pain Concepts, Inc., DEKOMPRESSOR Product Line	Oct 2002	$10
ConMed	Bionx	Mar 2003	$48
Synthes-Stratec	Spine Solutions	Apr 2003	$350
J&J	Link Spine Group Inc.	May 2003	$325
Zimmer	Sulzer (Centerpulse)	Aug 2003	$3527
Synthes-Stratec	Mathys	Aug 2003	$1111
Medtronic	Vertelink	Nov 2003	$22
Biomet	Biomet Merck B.V.	Dec 2003	$300
Smith & Nephew	Midland Medical Technologies, Ltd	Mar 2004	$180
Zimmer	Implex Corp.	Mar 2004	$108
Stryker	SpineCore	Jul 2004	$360
DJO	Osteoimplant Technology, Inc.	Feb 2005	$16
NuVasive	Pearsalls Limited, Assets and Technology	Aug 2005	$45
Biomet	Interpore International	Oct 2005	$280
Medtronic	InnoSpine, Inc.	Dec 2005	$30
Smith & Nephew	Osteobiologics, Inc.	Jul 2006	$72
Orthofix	Blackstone Medical	Aug 2006	$333
Medtronic	St. Francis Medical Technologies, Inc.	Dec 2006	$753
Medtronic	Disc-O-Tech Medical Technologies, Ltd., Spine Related Product Assets	Dec 2006	$240
Wright Medical	DARCO International	Mar 2007	$17
Smith & Nephew	Plus Orthopedics	Mar 2007	$907
Zimmer	Endius	Apr 2007	$80
Acquirer	Target	Date	Value (USD Millions)
Sulzer (Centerpulse)	Spine-Tech	Dec 1997	$653
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Table 2 (continued)

Acquirer	Target	Date	Value (USD Millions)
ConMed	Bionx	Mar 2003	$48
Synthes-Stratec	Spine Solutions	Apr 2003	$350
J&J	Link Spine Group Inc.	May 2003	$325
Zimmer	Sulzer (Centerpulse)	Aug 2003	$3527
Synthes-Stratec	Mathys	Aug 2003	$1111
Medtronic	Vertelink	Nov 2003	$22
Biomet	Biomet Merck B.V.	Dec 2003	$300
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Zimmer	Endius	Apr 2007	$80

from M&A activity between the top 10 orthopaedic device companies, with Zimmer and J&J (DePuy) leading intragroup mergers between top 10 companies. In 2002, Zimmer acquired Sulzer for $3.2 billion in cash-and-stock, the first acquisition between top 10 firms from 1999 to 2015. In addition, Zimmer completed four acquisitions with publicly accessible transaction values for a total amount of ~ $600 million before its merger with Biomet, a deal valued at $13.35 billion. Sulzer (acquired Spine-Tech for $595 million) and Biomet (acquired Lanx and Interpore International for $147 and $280 million, respectively) completed transactions of their own as a separate entity, and the total collective value of Zimmer's acquisitions is estimated to be $18 billion.

Similarly, Johnson & Johnson has acquired various companies since its hallmark acquisition of DePuy in 1998. It acquired Synthes (formerly known as Synthes-Stratec) in April 2011 for $21.3 billion; Synthes had acquired Mathys, another initial top 10 orthopaedic device firms, for $1.1 billion in August 2003, and made two other acquisitions for a total of $380 million (N Spine Inc., Spine Solutions). Altogether with DePuy's acquisition of AcroMed for $325 million, the J&J family of orthopaedic firms is estimated to be worth $26.5 billion. Other top 10 companies have similarly made a string of acquisitions, with Stryker participating in 12 transactions for a total deal value of $7.2 billion, Medtronic spending $10.5 billion on 12 acquisitions, Smith & Nephew spending $3.6 billion on seven deals, and Wright Medical acquiring seven companies for a total of $3.9 billion (Table 3).

Ultimately, the composition of the top 10 companies has changed considerably over time. In 1999, the industry was

Table 3 Significant M&A transactions in orthopaedic device market from 1998 to 2015

Company	Total transaction value (USD $M)	Number of transactions
J&J	$25,813	4
Zimmer	$18,187	8
Medtronic	$10,457	12
Stryker	$7185	12
Wright medical	$3938	7
Smith & Nephew	$3581	9
DJO	$1612	3
Synthes-Stratec	$1536	3
Biomet	$1007	4
Sulzer (Centerpulse)	$653	1
Orthofix	$333	1
DePuy	$325	1
Tornier	$157	1
NuVasive	$138	2
Globus medical	$63	1
ConMed	$48	1

comprised of two large firms with > $1 billion in revenue and eight smaller-sized companies with < $1 billion in revenue. In 2015, there were three industry leaders ($5 + billion in revenue), three midsized firms ($1–3 billion in revenue), and four small firms (< $1 billion in annual sales). Figure 2 shows the layout of the top 10 companies over time depicting key M&A transactions.

Acquisition of smaller orthopaedic device firms by industry stalwarts

In addition to the consolidation that resulted from Zimmer and J&J's history of acquisitions, almost every original and new top 10 company has been a participant in the M&A activity in the industry. Stryker has acquired ten companies with an aggregate value of $6.6 billion, with important acquisitions such as Howmedica ($1.9 billion), Porex Surgical ($1.4 billion), and MAKO Surgical ($1.65 billion). Similarly, Smith & Nephew has acquired five companies for an aggregate total of $3 billion in transaction value (e.g., Arthrocare for $1.7 billion, Plus Orthopaedics for $889 million). Medtronic has also been active, acquiring fellow top 10 firms, Kyphon, for $3.9 billion in July 2007, in addition to eight other orthopaedic firms for an estimated total value of $8.8 billion. The Wright Medical Group merged with Tornier in October 2015, and the deal in 2014 (estimated to be worth $3.3 billion) consolidated the tenth smallest firm with a peer of similar size in the orthopaedic device market.

Discussion

The orthopaedic device market has grown at a rapid pace over the past two decades, with an overall CAGR of 8.9% between 1999 and 2015. Within this, however, growth was far higher between 1999 and 2008 (CAGR = 12.0%) than between 2009 and 2015 (CAGR = 2.8%) (Table 1). Growth

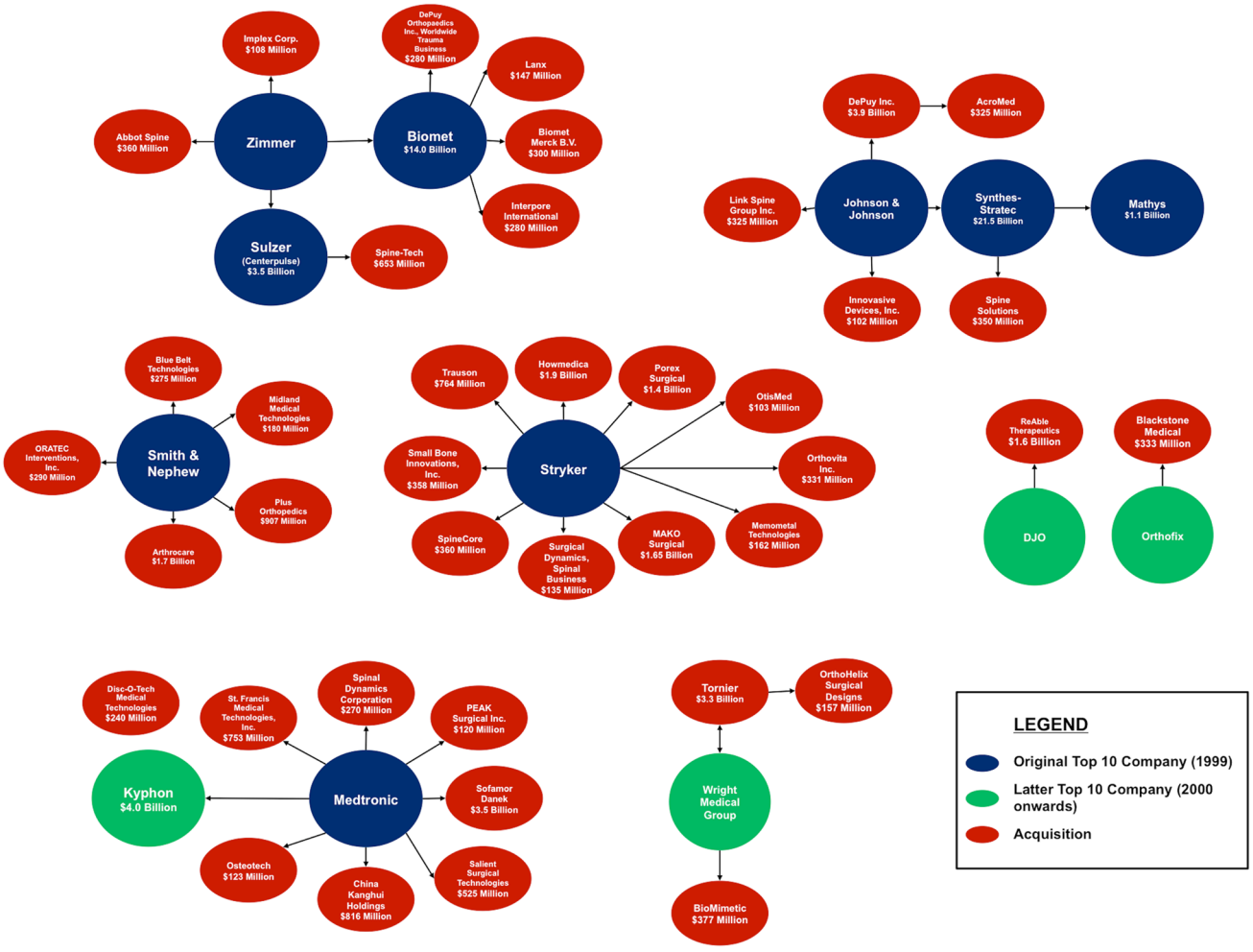

Fig. 2 Orthopaedic device market showing M&A

in the overall orthopaedic device market is therefore slowing, even as healthcare needs rise [5, 6, 20, 21].

The orthopaedic devices market is consolidating as growth slows, with market share becoming increasingly concentrated among the largest firms. Rising M&A activity was observed through both the acquisition of smaller companies and also through industry stalwarts (e.g., Zimmer-Biomet, J&J-Synthes) (Fig. 1). These transactions are in part responsible for the market share of the largest five manufacturers of orthopaedic devices increasing from 52.8 to 62.2% between 1999 and 2015, even as it decreased from 72.7 to 70.5% for the ten highest grossing companies. Both market consolidation and decreased overall growth are both indicators of a maturing orthopaedic device industry.

There are several limitations to this study. Many transaction terms are left undisclosed even if the acquirer is a large publicly traded company, and this is especially common among smaller deals involving start-ups or pre-revenue stage companies. In addition, given the time frame of interest extends back past 1999, not every company Web site provided accessible SEC filings or press releases; for clarification, this time period of interest was selected given that financial data from the early 1990s are not easily accessible. As a result, information regarding M&A activity could not be sourced from one central source, and instead a comprehensive and thorough process was required (see Methods).

Orthopaedic device market maturation may result from hospital mergers and changing procurement practices. Consider, for instance, that the cost of an orthopaedic device takes up a large share of the total cost of surgery, averaging 43–50% of total costs and reaching as high as 87% [12, 22]. Hospitals work to lower costs and negotiate more competitive procurement contracts [12]. In theory, consolidated device markets may therefore be better able to negotiate with merged hospital providers and withstand lower profit margins.

These trends have multiple important implications for the practice of medicine. While large orthopaedic firms may merge to capitalize on improved economies of scale, consolidation may lead to price collusion and oligopolies that could, in turn, raise healthcare costs [23]. Even if this were to occur, emerging value-based payment systems and mechanisms for price transparency may bolster the bargaining power of patients and clinical providers. In addition, there is growing interest in developing generic replicas of implants for hip/knee arthroplasties [24]. Through their influence on treatment costs and patient choice, these dynamics are nevertheless likely to impact measures of healthcare value moving forward.

As seen with recent mergers, the orthopaedic device market—and specifically that for hip and knee replacements—may have matured to the point where it may be difficult to develop a product that can markedly improve outcomes at a competitive price. To maintain growth, orthopaedic device manufacturers may therefore increasingly pivot toward high-growth sectors of the market, such as sub-specialties (foot and ankle, hand and wrist, elbow, and shoulder), biologics, and sports medicine. Such a shift would mean increased funding opportunities available for researchers and a potential accelerated rollout of new orthopaedic devices in relevant sub-specialties.

In summary, recent market trends may present both challenge and opportunity for value-based clinical decision making in the high-cost field of orthopaedic surgery. Market consolidation is likely to affect the pricing of orthopaedic devices moving forward, although it is challenging to predict which direction pricing will take, given the delicate balance between economies of scale and oligopolistic behavior. With respect to treatment choice, less competition may also reduce the number of alternative therapeutic options that become available in well-developed orthopaedic areas—for example, device markets for hip and knee replacements—relative to less-developed subfields. Careful stewardship of the evolving orthopaedic device market therefore seems essential to ensure that patients, on the whole, benefit from device spending.

Compliance with ethical standards

Conflict of interest Dr. Piuzzi has nothing to disclose. Mr. Ng reports personal fees from Thessalus Capital, outside the submitted work; Mr. Song has nothing to disclose. Mr. Bigach has nothing to disclose. Dr. Khlopas has nothing to disclose. Dr. Salas-Vega has nothing to disclose. Dr. Mont reports other from Abbot, other from Cymedica, other from DJ Orthopaedics, other from Johnson & Johnson, other from Mallinckrodt Pharmaceuticals, other from Microport, other from Ongoing Care Solutions, other from OrthoSensor, other from Pacira, other from Peerwell, other from Performance Dynamics, other from Sage, other from Stryker, other from TissueGene, outside the submitted work.

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