

Supplementary Table 1. Papers analyzed regarding physician practice acquisition and consolidation, including associated characteristics and risks/benefits identified by each investigation

Author(s)	Specialty	Type of Study	Data Source	Time Period Evaluated	Outcomes	Risk of Bias	Reporting Bias	Benefits of consolidation	Risks of consolidation
Anderson (2022) [45]	General Surgery	Physician consolidation	CMS Physician Compare Database	2012-2020	Practicing general surgeons increased from 20,044 to 20,637 (+3%). Unique general surgery practices declined from 8178 to 6489 (-21%). Practice size of 1 or 2 declined from 19% to 12%, while surgeons in groups of 500 or more grew from 20% to 31%	Unclear structure and characteristics of the groups undergoing consolidation; limited understanding of management dynamics	Only includes analysis of physicians participating in Medicare	Access to resources, technology, referral base, practice stability	Decrease autonomy, fewer options for practice structure, limited access to providers outside of network, higher costs of care
Barnes (2022) [66]	Multispecialty	Vertical Integration	IQVIA/SK&A	2008-2015	Vertical integration of practices increased by 100-200% during the study period across all 3 types of practices studied; vertically integrated practices are more likely to employ NPs and PAs than horizontally integrated (physician-owned) practices	Does not assess employment status of NPs and PAs or division of labor within vertically integrated systems	Groups may be missing national representation of practices	Improved physician and practice productivity	Unclear oversight requirements for NPs and PAs; easy satisfaction of regulations, negating their intentions
Boddapati (2022) [60]	Orthopedic Surgery	Private equity investment/acquisition	Thomson ONE, Capital IQ, Zephyr, CB Insights, and Private Equity Hub, 20-24 S&P Global Capital IQ	2004-2020	Between 2004 and 2019, 41 orthopaedic practices and surgeon groups across 22 states were acquired by 34 private equity and other investment firms. A significant increase was observed in the number of acquisitions between 2017 and 2019, consisting of 70.7% of total transactions during the study period	Inability to assess physician autonomy, satisfaction or compensation; Absence of data to demonstrate risks of benefits of consolidation	Lack of complete data including transaction and enterprise values, partial acquisitions, and recapitalization events	Increase infrastructure, hiring new physicians, increase ancillary services, improved negotiation with insurers	Change of priorities for leadership from patients/physicians to investors
Chen (2020) [61]	Ophthalmology, Optometry	Private equity investment/acquisition	Capital IQ, CB Insights, Thomson ONE, Prequin, Zephyr, Pitchbook, Factiva, PE Hub, The Wall Street Journal, and Vision Monday	2012-2019	228 practices associated with 1466 clinical locations and 2146 ophthalmologists or optometrists were acquired by 29 PE-backed platform companies; 42 practices were acquired between 2012 and 2016 compared to 186 from 2017 through 2019	Limited to private equity acquisition; search data did not include eyewear retailers or manufacturers, which may include further private equity investment	Limited to publicly disclosed private equity acquisitions; acquisition information may be incomplete	Consolidation can result in lower costs and better outcomes with regard to readmission rates and regular screening adherence	Unclear future reimbursement for procedures, impacting future profit potential; reduction of competition may lead to higher prices
Cwalina (2022) [46]	Urology	Physician consolidation	CMS Physician Compare Database	2014-2021	Number of urologists increased from 9173 to 9318, and number of	Unclear structure and characteristics of the groups undergoing	Only includes analysis of physicians participating in Medicare	Gradual trend towards sub-specialization, increasing	Underserved populations or regions may face decreased access to care and

					practices decreased from 3137 to 2460. Solo or partnership practice declined by 15.9% compared to larger practice groups which increased by an average of 5.1%. Providers within the Northeast US illustrated the largest migration to larger practices with 101%, 162% and 232% growth among practices with 25-99, 100-499 and over 500 providers, respectively.	consolidation; limited understanding of management dynamics; confounding factor of COVID-19 pandemic		practice efficiency	difficulty recruiting and retaining providers; increased cost to patients
Figueroa (2020) [47]	Cardiology	Physician consolidation	CMS Physician Compare Database and Medicare PECOS, Dartmouth Atlas, Herfindahl-Hirschman Index (HHI)	2013, 2017	From 2013 to 2017, the number of practices with a cardiologist decreased from 8,642 to 7,709; average number of cardiologists in practice together increased from 3.6 $\pm$ 7.8 cardiologists per practice in 2013 to 4.3 $\pm$ 10.1 cardiologists per practice in 2017; during study period, there was a 0.1 increase in hospital-level HHI and increase of 0.34 cardiologists per practice	Study did not assess multi-specialty practices, and was limited only to consolidation of cardiologists into single specialty practices	Only includes analysis of physicians participating in Medicare; study does not account for alternate uses of Tax identification numbers (TIN)	Increased market power, improved negotiation ability, allows cardiologists to account for bundled payments and accountable care organizations	Negative financial costs for patients and policy-makers, increases in total costs and out-of-pocket spending
Griffin (2022) [48]	Gastroenterology	Physician consolidation	CMS Physician Compare Database	2012-2020	Practicing gastroenterologists increased from 12,766 to 13,934, while practice numbers decreased from 4517 to 3865. Number of practices with more than 9 physicians decreased by 23.9%. Number of practices with more than 100 physicians increased by 16.8%.	Many reasons for practice consolidation noted, but effects not well studied or elucidated.	Only includes analysis of physicians participating in Medicare	Capital and scale to invest in improved facilities, equipment; improved negotiation with payers; improve reputation and ability to navigate complex regulatory issues; decreased financial risk and shared overhead costs	Increased costs to patients and payers, with lower quality of care for patients. Patients also prefer smaller groups with higher satisfaction scores.
Henretty (2022) [49]	Orthopedic Surgery	Physician consolidation	IQVIA/Herfindahl-Hirschman Index (HHI)	2008-2019	Number of groups of orthopedic surgeons decreased by 27% from 2008-2019, with 2170 in 2008 down to 1590 in 2019. Number of practice sites increased from 3264 to 4345 in study period. Also increased vertical integration with increase from 10 to 33% of practices owned by hospital or health system.	Likely underestimation of practice acquisitions by private equity due to lack of publicly available data. Analysis included practices with at least 1 orthopedic surgeon, including data for multispecialty practices.	Data limited by using only IQVIA data, and is dependent on self-reporting	Pooled resources available for investment in infrastructure. Increased reimbursement	Decreased physician autonomy

Hogan (2021) [50]	Radiation Oncology	Physician consolidation	CMS Physician Compare Database	2012-2020	Number of radiation oncologists increase by 9% from 4300 to 4679, with decrease in number of practices by 11.5% from 1606 to 1422	Likely under-representation of radiation oncologists specializing in pediatrics, given use of Medicare data set.	Only includes analysis of physicians participating in Medicare	Shared burden for high cost of equipment, maintenance, software and personnel. Increased patient stability	Increased cost of healthcare, worse patient experiences, lower income for physicians
Kanter (2019) [51]	Multispecialty	Physician consolidation	IQVIA	2010-2015	In counties with the greatest Accountable Care Organization (ACO) penetration, there was a 4% increase in large physician groups (>50 physicians) when compared with counties with zero ACO penetration and 2.7% decrease in percentage of small practices (<10 physicians)	Analysis focused on Medicare Shared Savings Program (MSSP) accountable care organizations (ACOs); ACO participation is voluntary	Analytic sample limited to physicians in database most representative of physicians treating Medicare beneficiaries	Care coordination facilitated by ACOs	Higher prices, possibly lower quality care
Kimmey (2021) [67]	Multispecialty	Vertical Integration	IQVIA, AHRQ Compendium of US Health Systems	2016-2018	In 113 of 382 metropolitan statistical areas (MSAs), more than half of all physicians were in a health system by 2018 (increased from 47 in 2016), and consolidation increased by 92% between 2016 and 2018	Listing in the AHRQ Compendium, a hospital system requires at least one nonfederal general acute care hospital and group of physicians attached through common ownership or management	Data set limited to metropolitan statistical areas	N/A	N/A
Milligan (2021) [52]	Radiation Oncology	Physician consolidation	Medicare Provider Enrollment, Chain, and Ownership System	2013-2017	Number of practices of radiation oncologists decreased 3.8% from 1679 to 1615; number of physician radiation oncologists increased 9.4% from 4948 to 5415. Solo practices decreased 11% (708 to 627), large practices increased 50% (60 to 90)	Larger practices may use multiple taxpayer identification numbers (TINs); may cause underestimation of practice sizes. Study does not assess multispecialty consolidation	Only includes analysis of physicians participating in Medicare	Investment in new technology, facilitation of compliance with regulations; increased access to capital. Improved outcomes, coordinated care	Increased healthcare spending
Mitchell (2022) [68]	Surgical oncologists (Breast cancer)	Vertical Integration	CMS registry/Medicare Part B Claims data; SK&A physician surveys, surgery group websites	2003-2014	Dramatic practice structure changes including decrease from 74 to 51% of breast cancer surgeons in single specialty practices. Percent of employed surgeons rose from 10 to 20%. Percent of surgeons with ownership stake in ambulatory center or specialty hospital rose from 4 to 17%.	Unclear if results can be extrapolated to other states and populations. Unclear if reorganization of practice structures is unique to breast oncologic surgeons.	Data from Medicare Part B claims from 5 states- California, Florida, New Jersey, New York and Texas	Higher practice revenue, greater control over surgery schedule.	Higher surgical rates for patients of surgeons with ownership stake in ambulatory centers. Higher spending and prices with minimal effects on quality.
Muhlestein (2016) [53]	Multispecialty	Physician consolidation	Medicare Provider Enrollment, Chain, and Ownership System	2013-2015	Mean group size increased from 3.8 to 4.0. Median group size increased from 8.0 to 10.0.	Some specialists and pediatricians likely excluded due to limit in Medicare data	Only includes analysis of physicians participating in Medicare	Administrative support, investment in new technology, compliance	Higher prices

								with regulation, hedge against larger practice based contracts; better outcomes, lower population costs	
Nie (2022) [62]	Urology	Private equity investment/ acquisition	Financial databases, news outlets, practice websites, and Internet keyword search	2011-2021	69 practice acquisitions identified, 28.4% by hospital systems, 10.4% by multispecialty physician groups, 34.3% by urology practices, 29.9% by private equity-backed platforms (20); estimated that 7.2% of private practice urologists are employed by 1 of 5 private equity backed platforms	Initially, investigators sought platform financing data and acquisition data such as purchase price and percent of PE ownership, but could not identify; could not identify physician attrition	Limited to publicly disclosed private equity acquisitions; acquisition information may be incomplete	Improve a platform's purchasing and employing bargaining power; centralization of administrative tasks and cost-spreading of medical and information infrastructure	Decreased physician competition, increased healthcare charges for commercially-insured patients; vertically integrated ancillary services lead to increased utilization and cost from financial conflict of interest
Nikpay (2018) [69]	Multispecialty	Vertical Integration	SK&A data, National Plan and Provider Enumeration System	2007-2017	Vertical integration of cardiology and oncology practices was highest of all specialties in study period-increased by 34%. 51% of oncology practices that were independent in 2007 integrated with a hospital or hospital system by 2017	21 practice specialties examined in 4 categories-medical, primary care, surgical, and multispecialty	Survey based data requires self-reporting; did not include all US based physicians	N/A	N/A
O'Donnell (2020) [63]	Ophthalmology	Private equity investment/ acquisition	S&P Capital IQ and Irving Levin Associates Databases; reports published by Physicians First and Vision Monday; supplemented by interviews	2010-2019	Increase in PE acquisitions of ophthalmology practices from less than 10 each year from 2010 to 2014, to >30 in 2017 and nearly 50 in 2018	Small sample size, low generalizability; limited insight on outcomes such as the quality, cost, and use of care or on physician, staff, or patient experience	Number of practice acquisitions reported in study led to 35 interviews with leaders considering acquisition, or recently completed	Economies of scale in administrative functions (billing, HR, regulatory compliance, practice mgmt.); higher payer rates; rapid changes in environment can be better navigated by larger practice	Potential substitution by physician extenders; pressure to generate higher revenue
Pollock (2022) [54]	Emergency Medicine	Physician consolidation	CMS Physician Compare Database	2012-2020	In study period, number of ER physicians increased from 16531 to 33066, with increase in practice number from 4813 to 5241. Percent of ER physicians in groups sized less than 25 has decreased from 40.2% to 22.7%; groups of more than or equal to 500 physicians increased from 15.5% to 24%	Likely underestimates pediatric emergency room physicians; does not include nonphysician providers	Only includes analysis of physicians participating in Medicare	Reduced overhead cost, increased economies of scale, increased bargaining power for contracts, loans, and reimbursement; access to capital	Standardized care may supercede individualized care. Reduced patient satisfaction, difficulty in accessing care. Lower coverage in rural areas. Higher cost of care
Pollock (2021) [55]	Orthopedic Surgery	Physician consolidation	CMS Physician Compare Database	2012-2020	Increase in surgeon number from 21,216 to 21,553 with decrease in practices from 7,299 to 5,829; Decrease in solo	Likely excludes pediatric orthopedic surgeons	Only includes analysis of physicians participating in Medicare	Better outcomes, lower costs, increased coordination of care, improved perceptions of work	Increased healthcare spending; increased readmission rates, increased patient premiums

					practices from 13.2 to 7.4%			environment, lower burnout, increased stability of provider networks, increased economies of scale to reduce overhead and improve negotiation	
Quereshy (2022) [56]	Otolaryngology	Physician consolidation	CMS Physician Compare Database	2014-2021	Number of otolaryngology providers increased from 7763 to 9150; number of practices decreased from 3584 to 3152; number of practices with 1 or 2 providers decreased from 80.2 to 73.1%	Likely excludes pediatric otolaryngology surgeons	Only includes analysis of physicians participating in Medicare	Ability to weather higher administrative overhead from cost of real estate, equipment and business operations; integration of medical records and access to resources	Decreased access to patient care as small practices based on profitability; no improvement in cost of care, or improve the quality or access to care
Rosenkrantz (2020) [57]	Radiology	Physician consolidation	CMS Physician Compare Database	2014-2018	Fraction of practices with 1-2 members decreased from 26.9% to 22.8%; fraction with 100-499 members increased from 7.6% to 10.2%; >500 members from 2.5% to 4.1%. Increase in number of radiologists from 30,492 to 32,096; decrease in practice number from 4,908 to 4,193	Likely excludes pediatric radiologists; recent bias due to more recent data sets; does not include nonpublic information such as year of establishment or reason for consolidation	Only includes analysis of physicians participating in Medicare	Operational and economic benefits from economy of scale; greater access to capital and technology; better scheduling for physicians, improved lifestyle, bargaining power with payers	Unclear if quality, cost or access to care is improved; demand for higher prices may increase cost of care
Singh (2021) [58]	Neurosurgery	Physician consolidation	CMS Physician Compare Database	2014-2019	Practices with 1-2 physicians decreased from 20.09 to 13.05%. 3-9 members decreased from 17.7 to 9.41%; 10-24 members from 10.53 to 8%. Increase in organizations with >1000 physicians from 9.85 to 22.84%.	Larger health networks likely over-represented in analysis; under-representation of pediatric neurosurgeons; short window of data to assess consolidation rates	Only includes analysis of physicians participating in Medicare	Decreased burden of administrative and business decisions; improved work-life balance; access to resources to improve practice operations	Smaller practices have higher physician satisfaction and lower burnout rates; compensation lower in larger practices
Tan (2019) [64]	Dermatology	Private equity investment/acquisition	Capital IQ, CB Insights, Zephyr, Thomson ONE, and PitchBook; public data from Bloomberg, Crunchbase, PR Newswire, and Business Wire	Prior to 2018	17 PE-backed dermatology management groups (DMGs) acquired 184 practices; rate of practice acquisition accelerated from 5 in 2012 to 59 in 2017. Acquired practices represented 381 dermatology clinics and spanned 30 states	Likely missing transactions due to nature of acquisitions by PE-backed DMGs; small acquisitions likely not reported; footprint of new clinics likely underreported because study focused on acquisition, not organic growth	Transactions limited to those in only 5 databases	Economies of scale in administrative functions (billing, HR, regulatory compliance, practice mgmt.); higher payer rates; can offer lower rates for exclusivity; increased capital for investment	Loss of physician autonomy, conflicts of interest from profit-seeking behavior such as self-referral, employment of mid-level clinicians or physician extenders, poor physician supervision of extenders, short term profit motivations
Tsai (2021) [59]	General Surgery	Physician consolidation	CMS Physician Compare Database	2013-2017	Number of general surgery practices decreased from 10 432 to 8451, while number of surgeons increased from 24958 to 26250. Proportion of surgeon practices	Does not consider effects of multispecialty practices; markets may be incorrectly defined by hospital referral regions;	Only includes analysis of physicians participating in Medicare	Assistance with higher costs associated with quality metrics; improved response to alternative payment models and	Higher patient prices, greater out of pocket spending, increased complications, decreased patient satisfaction

					with 1 physician decreased (26.2 to 17.4%), decreased with 2 (from 8.3 to 6.6%), and decreased with 3 to 5 (from 18.0% to 16.5%). Increase in proportion of practices with 6 or more surgeons (47.6 to 59.5%). Association found between hospital consolidation and surgeon practice consolidation.	hierarchical structure not considered in consolidated practices		accountable care organizations; distributed financial and administrative costs; increased market power	
West (2017) [70]	Multispecialty	Vertical Integration	Irving Levin Associates Health Care M&A data set; American Hospital Association survey data	2006-2013	Acquisition of physician practices increased from 32 in 2006 to 65 in 2013, peaking in 2011 at 108; 36.3% of acquisitions were by hospitals or health systems with remaining 63.7% by practice management associations, private equity firms or larger practice groups	Case study component of study was limited to small sample of only 4 sites; lack of generalizability of data and case study information	Limited to acquisitions disclosed in data sets analyzed only	Maintaining financial and organizational stability, increased market share for acquiring entity, improved negotiations with payers; ability to counter increased overhead, capital constraints and cashflow concerns	Removal of low-performing physicians; physicians not tied to acquiring entity, and have flexible exit clauses; lack of true integration of acquired practices; higher operating costs of acquired practices; self-referral pressure
Zhu (2020)[65]	Multispecialty	Private equity investment/acquisition	Irving Levin Associates Health Care M&A data set; SK&A data set	2013-2016	355 physician practice acquisitions (1426 sites and 5714 physicians) by private equity firms in study period- increased from 59 practices in 2013 to 136 practices in 2016. Acquired practices had average of 4.0 sites and 16.3 physicians; most common was anesthesiology at 19.4% and multispecialty practices (19.4%)	Underestimate of total transactions, particularly of smaller practices, and data lag	Data based on publicly announced transactions only	Platform practices growing value by acquisition by recruiting physicians, acquiring smaller groups, and expanding market reach	Financial pressure may affect practice stability, physician recruitment, quality, and safety