Venture capital investment in urology, 2011 to mid-2021

Logan G. Briggs, MD,[1]* Nishant Uppal, MD,[2]* Björn Langbein, MD,[3] Naeem Bhojani, MD,[4] Martin Kathrins, MD,[3] Quoc-Dien Trinh, MD[3]

[1]Department of Urology, Mayo Clinic, Phoenix, Arizona, USA
[2]Department of Medicine, Brigham and Women's Hospital, Boston, Massachusetts, USA
[3]Division of Urology, Brigham and Women's Hospital, Boston, Massachusetts, USA
[4]Department of Surgery, University of Montreal, Montreal, Quebec, Canada

BRIGGS LG, UPPAL N, LANGBEIN B, BHOJANI N, KATHRINS M, TRINH Q-D. Venture capital investment in urology, 2011 to mid-2021. *Can J Urol* 2023;30(5):11659-11667.

Introduction: *To characterize venture capital (VC) investments in urology in the past decade that represent promising innovations in early-stage companies.*

Materials and methods: *A retrospective analysis of deals made between VC investors and urologic companies from January 1, 2011, through June 28, 2021, was conducted by using a financial database (PitchBook Platform, PitchBook Data Inc). Data on urologic company and investor names; company information and funding categories (surgical device, therapeutic device, drug discovery/pharmaceutical, and health care technology companies); and deal sizes (in US dollars) and dates were abstracted and aggregated. Descriptive and linear regression analyses were conducted.*

Results: *Urology-related VC funding fluctuated from 2011 through mid-2021, but no substantial change was observed in funding over time. In total, 191 distinct deals were made involving urologic companies, totaling $1.1 billion. The four largest funding categories together accounted for $848 million and comprised therapeutic devices ($373 million), surgical devices ($187 million), drug discovery/pharmaceuticals ($185 million), and health care technology ($102 million). At least $450 million (41% of total investments) was invested in companies developing minimally invasive surgical devices.*

Conclusions: *Urologic VC investments did not increase in the past decade and were allocated more toward devices than pharmaceuticals or health care technology. Given relative patterns within urology, VC investments may shift toward health care technology and away from pharmaceuticals but remain stable for devices. Further investments in promising technologies may help urologists more effectively manage urologic disease while optimizing outcomes.*

Key Words: health care economics and organizations, health care technology, medical devices, pharmaceutical, urology

Accepted for publication June 2023

*Contributed equally to this manuscript.

Acknowledgment
Kathleen Louden, ELS, senior scientific/medical editor, Mayo Clinic, substantively edited the manuscript. The Scientific Publications staff, Mayo Clinic, provided proofreading, administrative, and clerical support. Mayo Clinic does not endorse specific products or services included in this article.

Address correspondence to Dr. Logan G. Briggs, Department of Urology, Mayo Clinic, 5777 E. Mayo Blvd, Phoenix, AZ 85054 USA

Introduction

Venture capital (VC) supports innovation in medical therapeutics, devices, and care by early-stage companies. VC is a form of private funding, whereby investors provide capital and guidance to early-stage firms in exchange for equity and board membership to help ensure growth and future capital gains.[1] Commonly, such firms or their developed products are later acquired by larger firms to finalize product development, commercialization, and distribution.[2]

In health care, VC investments are increasing, from $1.8 billion (all investments are reported as US dollars)

invested in 2010 to a record $16.8 billion in 2020.[3] Urology may be seen as a field ripe for VC investment. Urology spans medical and surgical domains, with a long history of innovation in drugs, devices, and technologies that have improved the quality of patient care.[4,5] Additionally, demand for urologic services is increasing by an aging population, and a drastic mismatch is occurring between the rate of retirement and the training rate of new urologists.[6,7] Experts project that urologists and advanced care practitioners might not meet demand over the next 20 years, and they call for creative solutions to this impending workforce shortage.[7] Increases in VC investment in urology can accelerate the commercialization of validated technologies and expand access to therapeutics for previously refractory disease;[8] however, the complete extent of VC investments in urologic companies, including the various device, pharmaceutical, and technology companies, is unknown. In this study, we sought to describe all VC investments in urology over the past decade and to compare patterns with those in other surgical subspecialties where such data are available.

Materials and methods

Data source

The PitchBook financial database (PitchBook Data Inc) is a private capital market data provider that offers insight into companies, contracts, funds, investors, and service providers across the entire private investment life cycle.[9] PitchBook classifies any of the following private transactions as VC investment: product and equity crowdfunding, accelerator and incubator programs, angel investing, seed funding, early-stage financing, and later-stage financing.[9] PitchBook categorizes companies into several funding categories by type of product: surgical device companies, therapeutic device companies (physical therapy and rehabilitation devices), drug discovery (research and development) companies, pharmaceutical companies, and health care technology systems (including software).[9] PitchBook finds finalized transactions in the private markets via its web crawling algorithms, which regularly scan company websites, regulatory filings, press releases, and similar sources; the company also regularly collects transaction data through partnerships with fund managers, partners, and investors.[9] Distinct transactions between investors and companies are termed deals.

Data collection and analysis

To analyze each VC investment, each VC investor, and the companies receiving the most VC investments, we interpreted investments on a deal level. We conducted a retrospective cross-sectional analysis of finalized VC deals involving urologic companies in the US from January 1, 2011, through June 28, 2021, using the PitchBook financial database.[9] Similar to published methodology from related studies in other specialties,[10,11] the search term queried through company and industry keywords to identify deals of interest was the name of the specialty, urology. We abstracted the total number, distribution, and funding area of all VC investments fulfilling these criteria and calculated the total value of investments over the study period. We abstracted additional information from PitchBook about the deals involving companies that received the most VC per funding category and investment companies that made the greatest number of deals. Additional information analyzed were the company name, company description, capital raised in US dollars, number of deals made, and size (dollar amount) of each deal.

Descriptive analyses were conducted by using a spreadsheet (Microsoft Excel 2016, Microsoft Corp) at the end of June 2021. Because we rounded dollar values, totals within the text may be slightly higher or lower than actual calculations. Because the data did not include information on human participants, the study was considered exempt from review by the Harvard Medical School Institutional Review Board.

Results

Over the past decade (2011 through mid-2021), VC firms made 191 distinct deals with urologic companies, totaling more than $1.1 billion. The average deal was $6 million. The total dollar value of VC investments peaked in 2015 at $229 million, Figure 1. From January 1,

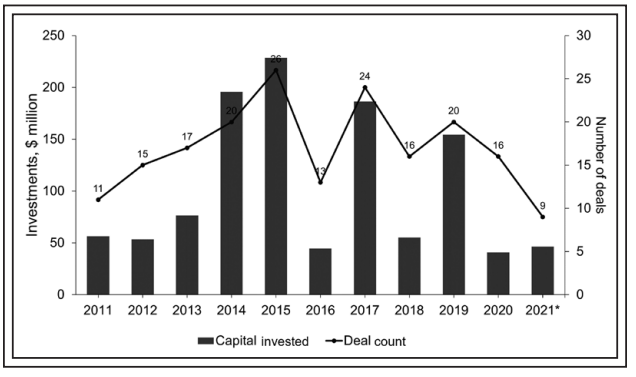

Figure 1. Total value and growth in venture capital investments in urologic companies, 2011-2021.* Asterisk indicates as of June 28, 2021; USD, US dollars. Data abstracted and aggregated from PitchBook (PitchBook Data Inc).

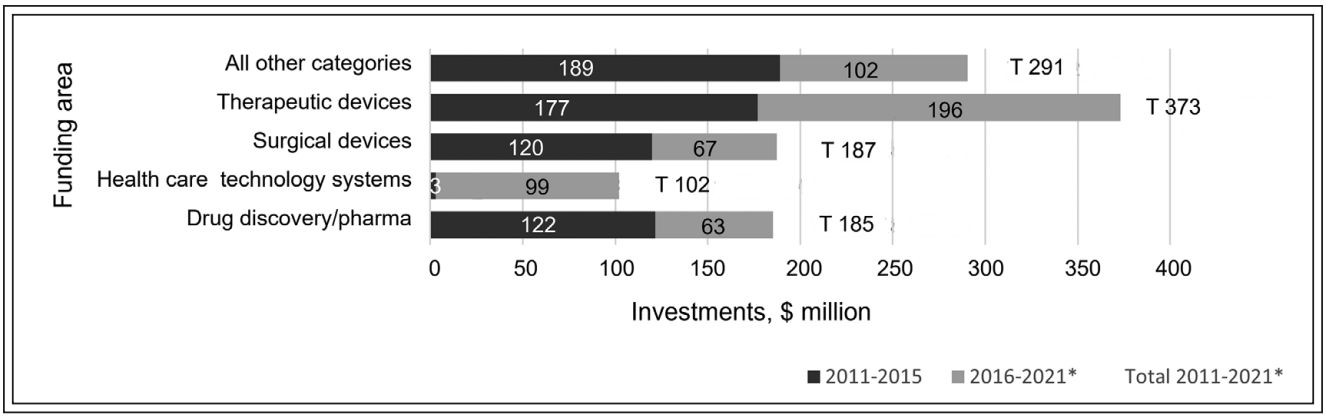

Figure 2. Venture capital investments in urologic companies by funding area, 2011-2015 vs. 2016-2021.* Asterisk indicates as of June 28, 2021; pharma = pharmaceuticals; T = total. Data (in US dollars) abstracted and aggregated from PitchBook (PitchBook Data Inc).

2011, through June 28, 2021, $46 million was invested, which if annualized would represent $95 million. Total annual VC funding each year from 2010 to 2020 varied greatly, without a clear pattern. Investments spanned a variety of urologic indications, and in the decade examined in this study, four funding categories each received $100 million or more: 1) therapeutic devices ($373 million), 2) surgical devices ($187 million), 3) drug discovery and pharmaceuticals ($185 million), and 4) health care technology systems ($102 million), Figure 2. Thus, these four funding categories together accounted for $848 million (75.1%) of the total $1.1 billion invested over the decade.

Of this $848 million, $744 million (88%) was invested in the five companies receiving the most VC funding per funding category, Table 1. This represented 17 companies total because some categories had fewer than five companies capturing all reported VC investment. Of the $744 million, $450 million was invested in companies developing minimally invasive surgical (MIS) devices for treatment of benign prostatic hyperplasia (BPH), robotic or laparoscopic procedures, or kidney stone removal, which represented approximately 40% of the total $1.1 billion invested in the past decade. Possibly, additional companies developing MIS devices were not represented in the investments shown in Table 1. Of the $450 million received by MIS device companies included in our analysis, $272 million (60%) was invested in four companies that develop devices for procedural management of BPH (NeoTract, NxThera [subsequently purchased by Boston Scientific], Zenflow, Urotronic, and Corinth MedTech). The remaining $177 million (39%) was invested in four companies developing other MIS devices. These products were robotic and laparoscopic devices (AirSeal and AnchorPort, ConMed SurgiQuest) and mechanical laparoscopic instruments (Axius Needle Driver, FlexDex Surgical); a drug delivery system that allows for continuous release of anticancer medication into the bladder, shifting treatment from the hospital or clinic to home (GemRIS, Taris Biomedical); and a vacuum-assisted kidney stone retrieval device (CVAC, Calyxo). Both AirSeal and AnchorPort are now US Food and Drug Administration (FDA) approved, as is the Axius Needle Driver. The CVAC has FDA premarket approval, and GemRIS is still investigational.

We identified the most active investors as those making at least three distinct investments from 2011 through mid-2021. Table 2 shows those investors with the investment size and the recipient of each investment. Of the 187 distinct deals made by 187 distinct investors, 20 investments were made by the five most active investors, who each made four deals from 2011 through 2021. All relevant, deidentified data supporting the findings of this study are reported within the article.

Discussion

Findings from our retrospective analysis of VC investments in urology over the past decade (2011-2021) showed that VC funding in urology has been flat, with large year-to-year fluctuations. These findings are surprising given the history of urologic innovation and the market research evidence showing an 833% increase in overall VC funding for health care from 2010

TABLE 1. **Companies receiving most venture capital**

Category	Company	Category and indication	Venture capital raised (millions of US dollars)
Drug discovery and pharmaceuticals	Afferent Pharmaceuticals	Biopharmaceutical products (diversified)	89.0
	Outpost Medicine	Biopharmaceutical products for treatment of urologic/gynecologic disorders	61.0
	UroGen Pharma	Biopharmaceutical products for treatment of uro-oncologic disease including thermal gel for localized treatment	17.0
	TheraVida	Biopharmaceutical products for overactive bladder and urinary incontinence treatment	11.5
	Contura	Drug delivery technologies for treatment of urinary incontinence	7.0
Health care technology systems	Healthy.io	Urinalysis mobile app for home-based urine tests	95.0
	Lazarus 3D	3-dimensional printing of anatomical models	7.0
Surgical devices	NeoTract	Implant systems for BPH (UroLift)	63.4
	SurgiQuest[a]	MIS robotic and laparoscopic devices (AirSeal and AnchorPort)	57.5
	Corinth MedTech	Endoscopic tissue resection and coagulation technologies for treatment of BPH and TURBT	20.7
	FlexDex Surgical	MIS mechanical laparoscopic instruments	16.8
	Calyxo	Kidney stone retrieval devices	15.0
Therapeutic devices	Taris Biomedical	Continuous-releasing drug systems for treatment of bladder cancer and disease	87.7
	NxThera[b]	Thermal therapy device (Rezum) for treatment of prostate cancer, BPH, and other endourologic conditions	67.8
	Urotronic	Drug-coated balloon device (Optilume) for treatment of urinary tract conditions	61.0
	Zenflow	Implant systems for treatment of BPH	59.6
	PercuVision	Urinary catheterization systems	7.2

BPH = benign prostatic hyperplasia; MIS = minimally invasive surgical; TURBT = transurethral resection of bladder tumor.
[a]Subsequently purchased by ConMed.
[b]Subsequently purchased by Boston Scientific.

through 2020.[3,5] Increases in health care investments by venture capitalists from 2017 through 2020 were driven by investments in biopharmaceuticals ($8.5-$24.6 billion), diagnostic tools ($4.7-$10.3 billion), and health technology ($7.0-$11.3 billion from 2019 through 2020) more than investments in devices ($3.0-$5.4 billion).[3] In contrast, within urology over the past decade, $1.1 billion in venture funding was invested in devices ($561 million), far more than biopharmaceuticals ($185 million) or health technology and diagnostic tools ($102 million).

VC investments in devices

The early 2000s saw increasing investments in medical devices, especially from 2005 through 2007,[10,12] but over the past decade, device funding in health care slowed compared with other sectors.[3] We report herein that this pattern was also present within urology and could be related to stagnant venture funding in urology from 2011 through 2021. VC investment in therapeutic otolaryngologic devices was previously shown to be stable from 2008 through 2017, totaling $1.2 billion.[13] Another study was done of VC investments in orthopedic companies (not just devices), and results showed that $3.5 billion was invested from 2000 through 2019.[10] Investment patterns were positive from 2000 through 2009 but were negative from 2010 through 2019, meaning that investment in orthopedic companies declined over the past decade.[10] From 2011 through 2020, VC investment in ophthalmologic device companies totaled $1.6 billion, increasing from $353 million in 2011 to $680 million in 2020.[11] By comparison, VC investment in urologic companies developing surgical and therapeutic devices totaled $560 million, which may indicate that urology lags in VC investment compared with other surgical subspecialties.

Stagnating or flat VC investment in urology could also reflect an increasing regulatory burden associated with health research and development. Venture capitalists cite as responsible for these shifts the increasing costs and uncertainties associated with obtaining FDA approval, concerns over coverage and reimbursement policies for new products by the Centers for Medicare & Medicaid Services (CMS), and private payers.[14] According to a 2010 survey of more than 200 medical technology companies conducted at Stanford University, "unpredictable, inefficient, and expensive [FDA] regulatory processes are jeopardizing America's leadership position in medtech innovation."[15] Consequently, VC investments in health care have shifted from early-stage to late-stage companies and product development with less uncertainty and risk.[12,14] Thus, future innovators may need to account for ongoing challenges by bringing new technologies from the bench to the bedside and seeking alternative sources of early-stage funding rather than VC.

Patterns of VC investment may serve as a forward-looking indicator of the therapeutic approaches the field may soon be adopting. At least 40% of all investments were made in companies developing MIS devices, most of which were therapeutics targeting BPH, Table 1. Indeed, new technologies for BPH treatment have greatly increased, partly thanks to VC investing. NxThera's transurethral water vapor therapy (Rezum) is one of the most extensively used outpatient treatments of BPH. Rezum and NeoTract's BPH treatment (UroLift) are both FDA- and guideline-approved treatments.[16] Corinth Medtech's single-use rectoscope (Veloxion) is also FDA approved for BPH management.[16] Urotronic's urethral drug-coated balloon (Optilume) and Zenflow's nitinol coil urethral implant (Zenflow Spring System) both have pivotal trials completed or underway (PINNACLE [NCT04131907] and BREEZE [NCT04987138], respectively), and FDA approval is anticipated soon. BPH is projected to become more prevalent because of an aging population and increasing life expectancies,[17] and depending on the treatment method, 2% to 14% of men will need a second operation within 2 years.[18] Therefore, the increasing need for BPH treatment and the decreasing supply of practicing urologists make emerging treatment modalities for BPH attractive to venture capitalists. The patterns of substantial VC investments in MIS and BPH devices is unlikely to change over the next decade.

VC investments in biopharmaceuticals

Within the health care industry, VC funding in the biopharmaceutical sector has seen the largest increases, with a record $24.6 billion invested in 2020.[3] However, funding for drug research and development has increasingly shifted from private sources such as VC to public sources, such as the National Institutes of Health, whose grant funding for biomedical and biopharmaceutical research increased from $18 billion in 1995 to $41 billion in 2020.[19] Incentives for VC funding of pharmaceutical research may be less favorable because the knowledge generated from such research is difficult to retain and capitalize on exclusively within the company.[19] VC investments in biopharmaceuticals, similar to those in devices, have leaned toward later-stage companies with less risk and uncertainty associated with bringing drugs to market.[14] Similarly, investments in oncology and rare diseases are perceived to have fewer clinical, regulatory, and reimbursement risks, so companies with these foci have received increasing VC investment dollars.[3] Stagnation in urologic pharmacologic VC investment may be partly due to these shifts away from VC investment.

Within urology, limited VC investments in pharmaceutical companies did not follow industry patterns but were diversified in urologic focus and the company's developmental stage. For example, during this analysis, UroGen Pharma was a postinitial public offering, clinical-stage biotechnology company, whereas TheraVida and Contura International were smaller companies in earlier stages of funding. Additionally, some companies such as UroGen Pharma have a focus on uro-oncology, but most do not; Afferent Pharmaceuticals focuses on neurogenic

conditions, and Outpost Medicine and Contura have diversified focuses including stress urinary incontinence, overactive bladder, and irritable bowel syndrome. Given that oncology comprises 31% of all biopharmacologic VC funding in health care overall,[3] and that urologic cancers are so highly prevalent,[20] we were surprised that only 9% of investments across the top five pharmacologic companies clearly focused on oncologic disease during our study period. Furthermore, only 4 of the 17 companies featured in Table 1 focused on urologic oncology, a finding that may signal underinvestment in urologic oncology. An alternative reason could be that operative interventions are the mainstay of treatment for most urologic cancers, whereas chemotherapies are more consistently employed for many nonurologic cancers.

VC investments in health technology

VC investments in health technology and diagnostic tools have increased dramatically, especially during the COVID-19 pandemic. Increased consumer pressure for on-demand health care during the pandemic and the CMS telehealth expansion spurred a 300% increase in VC investment in these technologies from 2019 through 2020.[21] Even before the pandemic, VC funding of digital health technology increased 858% from 2010 through 2017.[22] Shah and Berry[23] showed that much of the nearly 23 times increase in VC funding of psychology and mental health care from 2013 through 2019 was driven by health technology companies. Many of these technologies focus on moving health care from the hospital to home, a pattern also seen within urology but to a lesser degree.

Most of the investment in urologic health care technology systems was in Healthy.io, a company with FDA approval for a smartphone app to enable at-home diagnostics testing for signs of kidney disease and urinary tract infections. Shifting the work up and management of urologic disease from the outpatient setting to the home has improved convenience and patient satisfaction,[24,25] access to care, patient outcomes,[26] use of medical resources, and costs. However, this focus is new, also spurred by the COVID-19 pandemic, and there remains much room for optimization of virtual urologic care. Thus, industry and VC funding patterns suggest that the environment is ripe for initiatives and companies aiming to shift urologic health care from inpatient to outpatient or home to improve convenience and quality of care for patients. Especially given the relative dearth of investment in this area over the past decade, urologic innovators may find success in securing VC funding for health technologies and diagnostic tools.

VC investors

The most active investors made only three or four deals with urologic companies over the entire 10.5-year span, many of which were deals with repeated, not unique, companies, Table 2. By comparing deal sizes, we showed that many companies received most or all of their funding from a single investor or set of coinvestors and that companies uncommonly received VC funding from more than a few investors.

Strengths and limitations

The biggest strength of this work is that to our knowledge, we performed the only representative analysis of VC investment specific to urology to date. Obtaining reliable data on deals and capital investments is challenging because of start-up ventures' and VC firms' private nature, their nondisclosure agreements, and competition. PitchBook's algorithms scrape the Internet for press releases, news articles, and other relevant information, and the database collects and reports data in a standardized way, allowing for characterization of overarching patterns and themes.

Some limitations exist, however. Because the PitchBook database contains only information published in publicly available articles, the data lack granularity for overly detailed analysis or definitive comparisons between VC investment patterns in urology and general health care. PitchBook also may miss deals or transaction amounts that are not publicly disclosed in press releases or articles. Furthermore, PitchBook may not specifically categorize deals involving large companies with broad foci (including urology) as urologic deals, so some deals may have been missed and VC investments in urology may have been underestimated in the present study. PitchBook's search engine limits searches to a single term (eg, urology), so although this may limit comprehensiveness, this single-term search is the standard approach to PitchBook analysis.[10,11] Additionally, only VC investment deals were included in the current analysis, which excludes other funding sources (ie, initial public offering, debt, reinvested profits, or private equity investments) that are often used by larger health care companies (eg, Novartis, Astellas Pharma Inc, Cardinal Health Inc). Finally, some companies with which investors made deals were not categorized within one of our included funding categories and were therefore not shown in Table 1 despite their having raised a large amount of capital; for example, Modernizing Medicine (an electronic health record) was categorized by PitchBook as application software rather than a technology system.

TABLE 2. **Most active investorsa**

Investor	Category	Deals No.	Total invested $ million	Deal 1 Company	Deal 1 Size, $ million	Deal 2 Company	Deal 2 Size, $ million	Deal 3 Company	Deal 3 Size, $ million	Deal 4 Company	Deal 4 Size, $ million
Ansonia Holdings	Investment holding company	4	77.0	Healthy.io	60.0	Healthy.io	14.0	Healthy.io	2.4	Healthy.io	0.6
Innova Memphis	US-based diversified VC	4	0.2	Urova Medical	0.1	Innometrix	0.1	Urova Medical	0.1	Urova Medical	0.02
MB Venture Partners	Health care VC	4	0.2	Urova Medical	0.1	Innometrix	0.1	Urova Medical	0.1	Urova Medical	0.02
Pentland Group	UK wholesale/ retail company	4	74.5	Modernizing Medicine	38.0	Modernizing Medicine	20.0	Modernizing Medicine	12.1	Modernizing Medicine	4.4
SV Tech Ventures	US-based diversified VC	4	29.8	Zenflow	24.4	UroDev Medical	3.2	Zenflow	2.1	UroDev Medical	0.2
Arboretum Ventures	Health care VC	3	87.2	NxThera	40.0	NxThera	25.6	NxThera	21.6	None	0
Astia	Angel group	3	57.4	Zenflow	24.4	Zenflow	31.5	Zenflow	1.5	None	0
Flagship Pioneering	Health care VC	3	87.7	Taris Biomedical	25.0	Taris Biomedical	32.0	Taris Biomedical	30.7	None	0
Karolinska Development	Health care PE/VC firm	3	NR	Pallette Life Sciences	NR	Pallette Life Sciences	NR	Pallette Life Sciences	NR	None	0
Polaris Partners	US-based diversified VC	3	87.7	Taris Biomedical	25.0	Taris Biomedical	32.0	Taris Biomedical	30.7	None	0
Revelation Partners	Health care VC	3	23.0	TheraVida	2.6	SurgiQuest	20.0	Advanced Surgical Concepts	0.5	None	0
ShangBay Capital	Health care VC	3	46.6	Corinth MedTech	12.0	Zenflow	31.5	Corinth MedTech	3.1	None	0
Summit Partners	Health care PE/VC firm	3	72.0	Modernizing Medicine	38.0	Modernizing Medicine	20.0	Modernizing Medicine	14.0	None	0
Tekla Capital Management	Health care investment Advisor	3	79.1	Decipher Urologic Cancers	8.0	Decipher Urologic Cancers	16.1	Afferent Pharmaceuticals	55.0	None	0
Y Combinator	Accelerator firm	3	3.4	UroDev Medical	3.2	UroDev Medical	0.1	Zenflow	0.1	None	0

NR = not reported; PE = private equity; UK = United Kingdom; VC = venture capital; [a]investments are reported in US dollars. Some values do not total correctly because of rounding.

Conclusion

From 2011 through mid-2021, VC funding in urology did not substantially increase as it has across health care overall. Also contrary to patterns seen for health care overall, urologic VC funding was allocated more toward surgical and therapeutic devices than pharmaceuticals or health care technology systems. Investments in devices have favored MIS technologies, especially for BPH treatment, which has led to major advances in the field, a trend that is unlikely to change. Pharmacologic VC investments were diversified in urologic disease focus, with much less focus on uro-oncology than would be expected. Additionally, VC investment patterns may continue to shift away from traditional VC to alternate private funding for biopharmacologic research and development, as seen in health care at large. VC investment in health technology increased in urology but less than in health care overall; however, with the increasing demand for telehealth, VC investment in urologic health technology may increase over the next decade. Further investments in promising technologies may help urologists more effectively cope with increasing demands for urologic procedures while optimizing effectiveness, costs, and patient satisfaction.

Disclosures

Dr. Quoc-Dien Trinh reports personal fees from Astellas Pharma Inc, Bayer, and Janssen Pharmaceuticals, outside the submitted work. He reports prior research funding from the American Cancer Society and Pfizer Global Medical Grants. Dr. Nishant Uppal reports income from Quantified Ventures and Ironwood Medical Information Technologies LLC outside the submitted work. Dr. Logan G. Briggs reports consulting fees from Delfina outside the submitted work and research funding from the Office of Scholarly Engagement at Harvard Medical School. Dr. Naeem Bhojani reports consulting fees from Boston Scientific Corp, Olympus Surgical Technologies America, and Procept BioRobotics Corp. The other authors report no conflict of interest.

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EDITORIAL COMMENT

Re: Venture capital investment in urology, 2011 to mid-2021

Briggs and colleagues have provided an overview of venture capital investment in Urology. They note that urologic venture capital funding has been allocated more toward surgical and therapeutic devices than pharmaceuticals or health care technology.[1] While the authors have performed a comprehensive review of these commercial urology investments, there has also been significant venture capital, also known as private equity, investment in large urology groups in the United States. An excellent review of the evolving venture capital investment movement in physician's urology group practices has been written by Kirsch and Kapoor.[2] Unlike the investments in urology biotechnology, devices and health systems that have remained stable over ten years as demonstrated by Briggs and associates, private equity acquisitions have accelerated to become a dominant form of urology practice consolidation in recent years.[3] These ventures involving equity investment in urology practices have achieved significant market influence in certain regions. In the future, more research is needed to assess the impact of private equity investment in all areas of urology research, product development and patient care.

Leonard G. Gomella, MD, FACS
Department of Urology
Thomas Jefferson University and Hospital
Philadelphia, PA, USA

References

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2. Kirsh GM, Kapoor DA. Private equity and urology: an emerging model for independent practice. *Urol Clin North Am* 2021;48(2):233-244.
3. Nie J, Demkowicz PC, Hsiang W et al. Urology practice acquisitions by private equity firms from 2011-2021. *Urol Pract* 2022;9(1):17-24.