



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

# The impact of the COVID-19 pandemic on vascular surgery practice in the United States

Nicolas J. Mouawad, MD, MPH, MBA,<sup>a,b</sup> Karen Woo, MD, MS,<sup>c</sup> Rafael D. Malgor, MD,<sup>d</sup> Max V. Wohlauser, MD,<sup>d</sup> Adam P. Johnson, MD, MPH,<sup>e</sup> Robert F. Cuff, MD,<sup>f</sup> Dawn M. Coleman, MD,<sup>g</sup> Sheila M. Coogan, MD,<sup>h</sup> Malachi G. Sheahan III, MD,<sup>i</sup> and Sherene Shalhub, MD, MPH,<sup>j</sup> Bay City, Lansing, Grand Rapids, and Ann Arbor, Mich; Los Angeles, Calif; Aurora, Colo; New York, NY; Houston, Tex; New Orleans, La; and Seattle, Wash

## ABSTRACT

**Background:** The coronavirus disease 2019 (COVID-19) pandemic has led to widespread postponement and cancellation of elective surgeries in the United States. We designed and administered a global survey to examine the impact of COVID-19 on vascular surgeons. We describe the impact of the pandemic on the practices of vascular surgeons in the United States.

**Methods:** The Pandemic Practice, Anxiety, Coping, and Support Survey for Vascular Surgeons is an anonymous cross-sectional survey sponsored by the Society for Vascular Surgery Wellness Task Force disseminated April 14 to 24, 2020. This analysis focuses on pattern changes in vascular surgery practices in the United States including the inpatient setting, ambulatory, and vascular laboratory setting. Specific questions regarding occupational exposure to COVID-19, adequacy of personal protective equipment, elective surgical practice, changes in call schedule, and redeployment to nonvascular surgery duties were also included in the survey. Regional variation was assessed. The survey data were collected using REDCap and analyzed using descriptive statistics.

**Results:** A total of 535 vascular surgeons responded to the survey from 45 states. Most of the respondents were male (73.1%), white (70.7%), practiced in urban settings (81.7%), and in teaching hospitals (66.8%). Almost one-half were in hospitals with more than 400 beds (46.4%). There was no regional variation in the presence of preoperative COVID-19 testing, COVID-19 OR protocols, adherence to national surgical standards, or the availability of personal protective equipment. The overwhelming majority of respondents (91.7%) noted elective surgery cancellation, with the Northeast and Southeast regions having the most case cancellations 94.2% and 95.8%, respectively. The Northeast region reported the highest percentage of operations or procedures on patients with COVID-19, which was either identified at the time of the surgery or later in the hospital course (82.7%). Ambulatory visits were performed via telehealth (81.3%), with 71.1% having restricted hours. More than one-half of office-based laboratories (OBLs) were closed, although there was regional variation with more than 80% in the Midwest being closed. Cases performed in OBLs focused on critical limb ischemia (42.9%) and dialysis access maintenance (39.9%). Call schedules modifications were common, although the number of call days remained the same (45.8%).

**Conclusions:** Vascular surgeons in the United States report substantial impact on their practices during the COVID-19 pandemic, and regional variations are demonstrated, particularly in OBL use, intensive care bed availability, and COVID-19 exposure at work. (J Vasc Surg 2021;73:772-9.)

**Keywords:** COVID-19; elective vascular surgery; vascular surgery practice; financial stress; occupational exposure; personal protective equipment; pandemic; OBL

The global pandemic of coronavirus disease 2019 (COVID-19) has led to unprecedented cancellation of elective surgeries in the United States and has posed a significant strain on the finances of health care systems. A recent report by the CovidSurg Collaborative projects that 28.4

million elective surgeries worldwide will be canceled or postponed in 2020.<sup>1</sup> During the height of the pandemic, tier classifications of surgical procedures were created to stratify the urgency of operations. The goals of these classification systems were to maintain optimal patient

From the Division of Vascular & Endovascular Surgery, McLaren Health System, Bay City<sup>a</sup>; the Division of Vascular Surgery, Michigan State University, Lansing<sup>b</sup>; the Division of Vascular Surgery, University of California Los Angeles, Los Angeles<sup>c</sup>; the Division of Vascular Surgery and Endovascular Therapy, The University of Colorado, Anschutz Medical Center, Aurora<sup>d</sup>; the New York/Presbyterian Weill Cornell School of Medicine, New York<sup>e</sup>; the Vascular Surgery, Spectrum Health Medical Group, Grand Rapids<sup>f</sup>; the Department of Surgery, University of Michigan, Ann Arbor<sup>g</sup>; the Department of Cardiovascular Surgery, University of Texas at Houston, Houston<sup>h</sup>; the Division of Vascular and Endovascular Surgery, Louisiana State University Health Sciences Center, New Orleans<sup>i</sup>; and the Division of Vascular Surgery, Department of Surgery, University of Washington, Seattle<sup>j</sup>

Author conflict of interest: none.

Additional material for this article may be found online at [www.jvasc.org](http://www.jvasc.org).

Correspondence: Sherene Shalhub, MD, MPH, FACS, Division of Vascular Surgery, Department of General Surgery, The University of Washington, 1959 NE Pacific St, Box 356410, Seattle, WA 98195 (e-mail: [shalhub@uw.edu](mailto:shalhub@uw.edu)).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

Copyright © 2020 by the Society for Vascular Surgery. Published by Elsevier Inc.

<https://doi.org/10.1016/j.jvs.2020.08.036>

outcomes, preserve essential equipment and resources needed to handle the volume of critically ill patients, and uphold the crucial public health guidelines for physical distancing.<sup>2-6</sup> Early reports have described the impact of these restrictions on local practice patterns amid the pandemic.<sup>7,8</sup> The objective of this study was to describe the vascular surgery practice pattern changes in the inpatient, ambulatory, and vascular laboratory settings associated with the COVID-19 pandemic in the United States during the period of April 14 to 24, 2020.

## METHODS

**Survey design.** The Pandemic Practice, Anxiety, Coping, and Support Survey was an anonymous cross-sectional survey on the effects of the COVID-19 pandemic on vascular surgeons developed by the Society for Vascular Surgery (SVS) Wellness Task Force. This analysis focuses on the survey responses related to pattern changes in vascular surgery practices in the United States, including the inpatient setting, ambulatory, and vascular laboratory setting. Additionally, questions regarding occupational exposure to COVID-19, adequacy of personal protective equipment (PPE), elective surgery practices, changes in call schedules, and redeployment to nonvascular surgery duties were included. The survey questions are included in the [Supplementary Information](#) (online only). The study was reviewed by the University of Washington Human Subjects Division and deemed exempt (#009926) owing to the minimal risk and nonidentifiable nature of the study. Consent by each participant was given by their individual response to the survey. A multimodality approach, previously described,<sup>9</sup> was used to disseminate the survey between April 14 and 24, 2020, inclusive. Dissemination modalities included the SVS membership electronic mailing lists, other organizational mailing lists, podcasts, newsletters, and social media platforms ([Supplementary Table](#), online only). The survey data were collected using a secure REDCap data capture platform hosted at the University of Washington.<sup>9,10</sup> The data were analyzed using descriptive statistics. Categorical data are presented as numbers and percentages. Continuous data are presented as means and standard deviation of the mean or median and ranges or interquartile range where appropriate. Data were compared using the Student *t*-test for normally distributed data and Wilcoxon rank-sum test for non-normally distributed data. Categorical data were compared using the Pearson  $\chi^2$  test. Data were analyzed using SPSS 19.0 for Windows (SPSS, Inc, Chicago, Ill).

## RESULTS

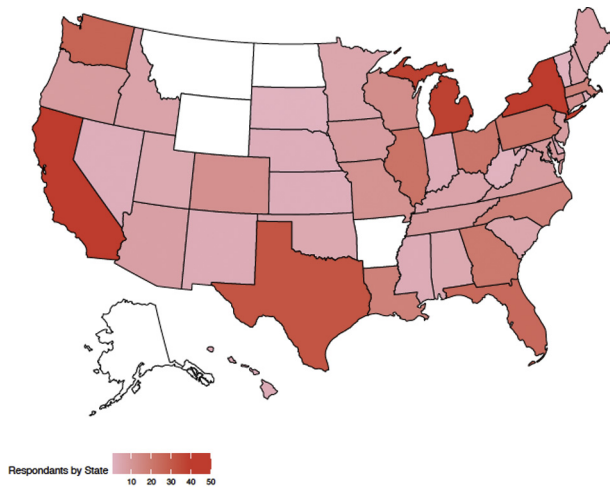
A total of 535 vascular surgeons in the United States responded to the survey from 45 states ([Fig 1](#)), with an evenly distributed response by region (25.8% Northeast, 22.8% Southeast, 23.6% Midwest, and 27.9% West/Southwest). The estimated response rate is detailed in

## ARTICLE HIGHLIGHTS

- **Type of Research:** The coronavirus disease-19 (COVID-19) Pandemic Practice, Anxiety, Coping and Support Survey for Vascular Surgeons is an anonymous cross-sectional global survey sponsored by the Society for Vascular Surgery Wellness Committee disseminated in April 14 to 24, 2020. This analysis focuses on the impact of COVID-19 on vascular surgery practice in the United States during this period
- **Key Findings:** The survey evaluated 535 vascular surgeons in practice in the United States with an even distribution in the four geographic regions: Northeast, Southeast, Midwest and West/Southwest. The COVID-19 pandemic resulted in significant impact to the practice of vascular surgery across the United States with unprecedented surgery cancellation, changes in on-call schedules, and redeployment to nonvascular surgical duties. Regional variation was noted in intensive care availability, outpatient-based laboratory, and COVID-19 exposure.
- **Take Home Message:** The COVID-19 pandemic had a significant impact on the practice of vascular surgery across the United States, with unprecedented surgical cases cancellation, changes in on-call schedules, and redeployment to nonvascular surgical duties. Regional variation was noted in intensive care availability, outpatient-based laboratory, and COVID-19 exposure.

the [Supplementary Table](#) (online only). New York was the state with the highest number of responses ( $n = 50$  [9.3%]), followed by California ( $n = 45$  [8.4%]) and Michigan ( $n = 38$  [7.1%]). A large proportion of the respondents were male (73.1%), white (70.7%), and practiced in urban settings (81.7%) and teaching hospitals (66.8%). Almost one-half of all respondents worked in a facility with more than 400 beds (46.4%; [Table I](#)). Most of the respondents completed the entire survey (91.2%), and there was no significant regional difference in completion rates (87.7%, 95.1%, 89.7%, and 92.6% respectively;  $P = .16$ ).

**COVID-19-related changes to in-hospital surgical practice.** Of the 480 vascular surgeons who answered the questions regarding intensive care unit (ICU) capacity, most noted that ICU beds were available at their hospital ( $n = 402$  [83.7%]), although others had patients boarding in the emergency department (14.6%), postoperative care unit, and/or operating rooms (11%). The lack of ICU beds was most common in the Northeast region, where more than one-quarter noted that ICU beds were at capacity, and patients were being boarded in the postanesthesia care unit (PACU)/operating room ([Table II](#)).



**Fig 1.** The geographic distribution of 535 vascular surgeons who responded to the survey. The regions were classified as Northeast (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont), Midwest (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin), Southeast (Alabama, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, and West Virginia) and West/Southwest (Arizona, California, Colorado, Hawaii, Idaho, Nevada, New Mexico, Oregon, Texas, Utah, and Washington).

The vast majority of respondents noted that all elective surgical procedures were canceled (452/493 [91.2%]) with no significant differences by type of hospital (92.6% teaching hospitals vs 89.2% nonteaching hospitals;  $P = .238$ ). A small number of vascular surgeons 8.3% (41/493) indicated that they were still performing elective cases focused primarily on dialysis access (58.5%), followed by aortic repair (51.2%), and lower extremity revascularization (48.8%; Fig 2). Elective surgery cancellations were most prevalent in the Northeast (94.2%) and least frequent in the West/Southwest region (86.3%).

Most respondents reported institutional adherence to the SVS and/or the American College of Surgeons (ACS) guidelines for elective surgery during COVID-19 (425/492 [86%]). Call schedules were modified for 45.9%, with the majority noting that they had the same overall number of call days in an altered distribution. Just over one-third of study participants (171 [34.8%]) were asked to assist in duties other than those of a vascular surgeon, most frequently in the Northeast region. The primary redeployment was to the ICU, and the most common reappropriation duty was placement of central venous catheters (Fig 3).

**COVID-19 operating experience and exposure.** A total of 452 of 492 respondents (91.7%) indicated they had dedicated COVID-19 operating room protocols at their

hospital, and 49% had preoperative testing of patients for COVID-19 available. Just under one-fourth of vascular surgeons ( $n = 131$  [24.5%]) had either operated on a patient or placed a central line (including hemodialysis catheters) on a patient with a confirmed COVID-19 infection (Table II).

Ninety-five vascular surgeons (17.8%) noted operating on a patient with a confirmed COVID-19 infection. In the majority of cases, the surgeons waited outside the operating room during the intubation (53.6%), and most used N-95 masks during the operation. When asked about their interaction within the operating rooms during the pandemic, some specific comments included, "I chose to wear excessive PPE on all patients during this time," "I have not operated since early March without an N95," and "I have elected to do nearly all operations without intubation." Central line placement on a patient with confirmed COVID-19 infection was performed by 96 of 535 vascular surgeons (17.9%). The majority indicated they had adequate PPE (94.8%). Ninety-six respondents (17.9%) operated on a patient who was later found to have a COVID-19 infection. In these circumstances, few were subsequently self-quarantined (6%) and/or tested for COVID-19 (10.4%).

Four respondents (0.7%) reported testing positive for COVID-19. A total of 147 (47.5%) indicated they were considered at high risk of being infected with COVID-19. Most were male (83%), and in practice for more than 20 years (54.4%). One-third of these respondents (34%) noted that they had operated on or placed a central line in a patient with confirmed COVID-19, with 14.3% of respondents being from New York State. Only two tested positive for COVID-19.

The Northeast had the most respondents who reported operating on a patient with COVID-19 or who was later found to be COVID-19 positive, and the West/Southwest region had the least (22.5% vs 9.4%;  $P = .006$ ).

**COVID-19-related changes in outpatient services.** The majority of vascular surgeons reported disruption to their outpatient clinic/ambulatory center schedules (440/493 [89.2%]). Changes included limited clinic/ambulatory center hours (350/493 [71%]) and use of telehealth (400/493 [81.1%]; Table III). A total of 15 respondents (2.8%) noted that owing to the crisis they offered no clinic and no telehealth services.

Two-hundred three respondents (47.7%) indicated that they have an office-based laboratory (OBL). Of those, 99 (48.8%) were still open, with the majority performing urgent procedures only and focused on peripheral arterial disease and dialysis access (Table III). Regional variation was identified with more OBL practices closing in the Northeast (65.2%) and Midwest (80.4%) as compared with the Southeast (31.5%) and West/Southwest (35.1%).

**Table I.** Description of the 535 vascular surgeons who responded to the survey and their practices

Characteristics	No. (%)
<b>Region</b>	
Northeast	138 (25.8)
Southeast	122 (22.8)
Midwest	126 (23.6)
West/Southwest	149 (27.9)
<b>Sex</b>	
Male	391 (73.1)
Female	134 (25.6)
Prefer not to say	7 (1.3)
<b>Race</b>	
White	378 (70.7)
Asian	80 (15)
Black or African American	10 (1.9)
American Indian or Alaska Native	—
Native Hawaiian or Pacific Islander	3 (.6)
Mixed race	14 (2.6)
Other	21 (3.9)
Prefer not to say	26 (4.9)
<b>Years in practice</b>	
<10	223 (41.7)
10-20	156 (29.2)
>20	156 (29.2)
<b>Type of hospital</b>	
Urban teaching	332 (62.1)
Urban nonteaching	105 (19.6)
Rural teaching	31 (5.8)
Rural nonteaching	25 (4.7)
No response	42 (7.9)
<b>Type of practice</b>	
Academic	253 (47.3)
Community	172 (32.1)
Multispecialty clinic	50 (9.3)
Outpatient practice only	11 (2.1)
Solo	22 (4.1)
Veterans' Affairs or government run	27 (5)
<b>Hospital size, beds</b>	
<50	4 (.7)
50-99	4 (.7)
100-200	49 (9.2)
201-300	91 (17)
301-400	83 (15.5)
>400	252 (47.1)
Don't know or no response	46 (8.6)
I do not work at a hospital	6 (1.1)
Practice at more than one hospital	307 (57.4)
Leadership position <sup>a</sup>	320 (59.8)

<sup>a</sup>“Do you have an institutional leadership position (eg, program director, vascular lab director, section head, division head, department chair)?”

**COVID-19-related changes in vascular laboratory scheduling.** Most of the respondents (96.7%) have a vascular laboratory, and the majority of vascular labs were performing urgent outpatient studies (351 [74.4%]; Table III). Some vascular laboratories limited imaging to life- or limb-threatening studies and others stratified imaging requests based on clinical need and urgency determined by the vascular surgeon on call. Several respondents noted the creation and establishment of a mobile vascular laboratory program that provided in-home services for select types of patients.

## DISCUSSION

The COVID-19 pandemic has changed the landscape of surgical practice in the United States, including cancellation and postponement of elective surgical cases and rapid dissemination of surgical practice guidelines with the goal of to preserving PPE and build capacity within health care systems.<sup>1,3,11-15</sup> This survey covers the period of April 14 to 24, 2020, during which cases in the United States rose increased 492,416 to 895,766, with the Northeastern region being most heavily affected.<sup>16</sup>

The majority of survey respondents implemented specific operating room protocols and had adequate PPE at their primary institution. In areas where shortages were evident or expected, such as the Northeast region, active measures by hospital leadership were instituted to convert PACU and operating rooms to ICU beds to allow for the surge, with operating rooms and PACUs being suitable based on their location, size, and available infrastructure.<sup>17</sup> ICUs were the most full in the Northeast, with a significant increase in patients boarded in the PACU/operating rooms as compared with the rest of the country.

With surgical guidelines for the pandemic in place and endorsed by surgical societies,<sup>2,3</sup> elective vascular surgical cases were decreased significantly, if not halted completely. Not surprisingly, the majority of the respondents canceled elective cases, adhering to guidelines set forth by national surgical and specialty societies, such as the ACS and the SVS.<sup>3,6</sup> The West/Southwest region had the fewest number of cancellations, which may represent the lower number of the COVID-19 cases with a downward trend at the time of this survey; Washington state was ground zero for the pandemic in the United States. Although only one-half of the respondents had preoperative COVID-19 testing for their patients, an overwhelming majority identified dedicated COVID-19 operating protocols at their institutions. There was no geographic variation in preoperative testing of patients for COVID-19, presence of OR protocols and PPE, or adherence to national guidelines. A focus on life-over-limb was clearly demonstrated, with the majority of continued elective cases focused on aortic repair and maintenance of dialysis function rather than peripheral arterial disease or venous procedures.

**Table II.** Coronavirus disease-19 (COVID-19) occupational exposure and related changes to in-hospital surgical practice

Variables	All	Region				P value
		Northeast	Southeast	Midwest	West/Southwest	
ICU availability (n = 480)						
ICU beds available	402 (83.8)	72 (62.1)	105 (90.5)	95 (83.3)	130 (97)	<.001
ICUs are full, patients are boarding in the ED	25 (5.2)	11 (9.5)	5 (4.3)	7 (6.1)	2 (1.5)	.038
ICUs are full, patients are boarding in the PACU/OR	53 (11)	31 (26.7)	6 (5.2)	13 (11.4)	3 (2.2)	<.001
The primary hospital or facility where you work has (n = 492)						
Preoperative testing of patients for COVID-19	243 (49.4)	67 (55.4)	55 (46.6)	52 (45.2)	69 (50)	.404
COVID-19 OR protocols	451 (91.7)	109 (90.1)	109 (92.4)	109 (94.8)	124 (89.9)	.47
Adheres to ACS/SVS guidelines for allowable surgeries during COVID-19	425 (86.4)	105 (86.8)	100 (84.7)	102 (88.7)	118 (85.5)	.826
Adequate PPE	396 (80.5)	98 (81)	87 (73.7)	101 (87.8)	110 (79.7)	.059
Elective surgeries cancelled (n = 493)	452 (91.7)	114 (94.2)	113 (95.8)	105 (91.3)	120 (86.3)	.032
COVID-19 exposure (n = 535)						
Operated on a patient with COVID-19	95 (17.8)	31 (22.5)	29 (23.8)	21 (16.7)	14 (9.4)	.006
Operated/performed a procedure on patient with COVID-19	131 (24.5)	47 (34.1)	39 (32)	26 (20.6)	19 (12.8)	<.001
Operated/performed a procedure on patient who was later diagnosed with a COVID-19 infection	96 (17.9)	36 (26.1)	30 (24.6)	17 (13.5)	13 (8.7)	<.001
Personally considered at high risk for COVID-19 infection	147 (27.6)	47 (34.4)	33 (27.3)	29 (23.2)	38 (25.5)	.201
Assist in duties other than those of a vascular surgeon (n = 492)	171 (34.8)	67 (55.4)	35 (29.7)	37 (32.5)	32 (23)	<.001
Call schedule (n = 472)						
Any call schedule changes in the last 2 weeks	216 (45.8)	63 (54.8)	45 (38.8)	64 (58.7)	44 (33.3)	<.001
Less call	27 (5.7)	12 (10.4)	1 (9)	8 (7.3)	6 (4.5)	.014
More call	57 (12.1)	20 (17.4)	13 (11.2)	10 (9.2)	14 (10.6)	.233
Same call but changed distribution of call	133 (28.2)	31 (27)	31 (26.7)	47 (43.1)	24 (18.2)	<.001

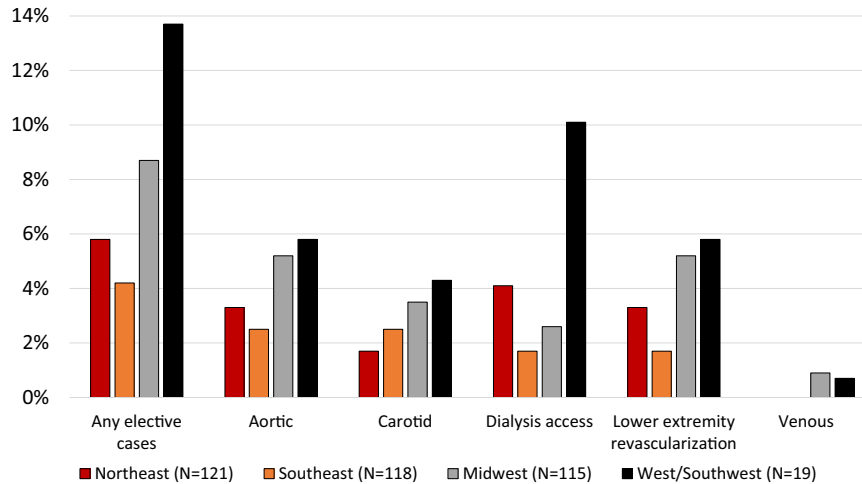
ACS/SVS, American College of Surgeons/Society for Vascular Surgery; ED, emergency department; ICU, intensive care unit; OR, operating room; PACU, postanesthesia care unit; PPE, personal protective equipment. Values are number (%).

Along with other healthcare workers, vascular surgeons have been redeployed to perform critical activities during the pandemic that are not part of their routine practice, similar to what has been seen in other specialties.<sup>11-15</sup> The most common redeployment was to the ICU, as well as the formation of central line teams to minimize multi-provider exposure and leverage the expertise of vascular surgeons. As expected, redeployment was most common in areas most affected by the pandemic, such as the Northeast region. On-call schedules were modified in terms of call distribution and frequency to promote physical distancing and minimize the exposure of multiple members of the team at a given time.

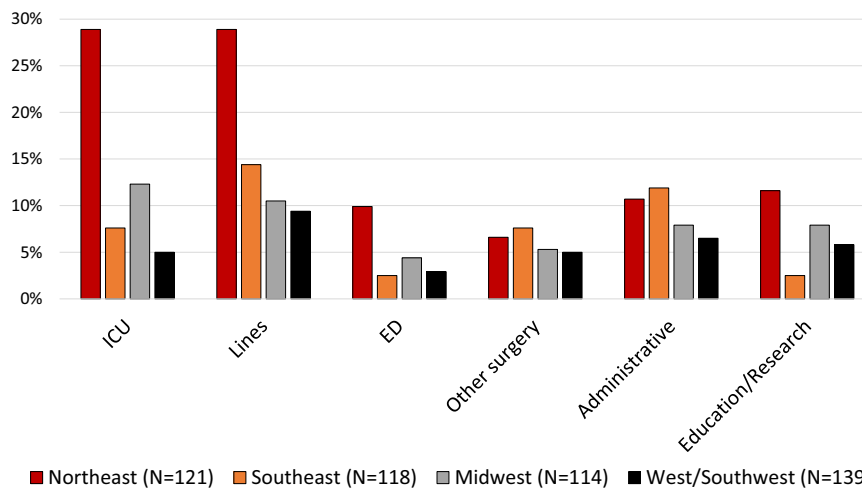
Contemporary vascular surgical practice has promoted outpatient management and encouraged the use of OBLs to offload the demands of larger hospital facilities. Despite their multiple benefits, changes in outpatient services were expected during this crisis, and many of the vascular practices limited their OBL hours; reasons included helping to promote physical distancing, minimizing provider exposure, unavailability of staff (owing

to financial restrictions and/or furlough at large health systems), and, most commonly, patients' fear of contracting COVID-19 in a health care facility. Most practices converted to offering consults via telephone or telemedicine/telehealth visits. The lack of in-person meetings has essentially become commonplace and telehealth is becoming a "must-have" for practice viability. Interestingly, 15 respondents noted that their offices closed and they offered no telehealth capabilities; this finding was not regionally specific. Significant regional variation was identified, with more than 80% of OBLs in the Midwest closing as compared with only 31.5% and 35.1% in the Southeast and West/Southwest, respectively. Chronic limb-threatening ischemia and dialysis maintenance were the types of cases most frequently being performed in the OBL setting.

The majority of respondents noted a shift toward the vascular diagnostic laboratory performing only urgent outpatient referrals and inpatient consults at their institutions. Mitigation options revolved around decreasing the frequency of the vascular laboratory evaluations or



**Fig 2.** The regional distribution of continued elective vascular surgical cases as reported by 41 respondents.



**Fig 3.** The regional distribution of duties to which vascular surgeons were redeployed. These included managing patients in the intensive care unit (ICU), taking shifts to assist the ICU teams in placing lines (lines), seeing patients in the emergency department (ED), covering other surgery services (other surgery), administrative tasks (administrative), and additional educational/research responsibilities (education/research).

decreasing hours of service. Clearly, delaying vascular pathology surveillance made many uncomfortable and options to maintain such schedules were explored. Urgent outpatient studies were still being performed without regional variation, although the Midwest continued to do a large proportion of inpatient evaluations.

Several limitations exist owing to the self-reported survey design, which can introduce social desirability bias, recall bias, and respondent selection bias. This survey is a snapshot of 10 days during a very dynamic situation of early COVID-19 experience, with circumstances changing daily. Some of the states were on the steep part of the pandemic curve and getting ready to peak, whereas others did not see large influx of infected patients at the time of survey completion. In particular, a significant number of respondents to the survey were from the

New York, Michigan, and California, all of whom were severely affected by the pandemic during this period. The majority of the respondents were from urban and teaching hospitals; thus, the responses reflect mostly this experience. The majority of the respondents were from urban and teaching hospitals thus the responses reflect mostly this experience. Also, surgeons may have appointments in more than one facility, such as joint appointments with the Veteran's Administration (VA). These surgeons may have selected their primary hospital rather than the VA; therefore, the VA may be underrepresented. Last, the timing of the survey development and dissemination coincided with the rapid development of practice guidelines and the common language we are now all familiar with such as the Vascular Activity Condition or VASCCON language or the tiers 1 to 3 by the ACS.<sup>3,6</sup> These were not incorporated in the survey design

**Table III.** Coronavirus disease-19 (COVID-19) related changes in outpatient and diagnostic vascular laboratory services

	Region					P value
	All	Northeast	Southeast	Midwest	West/Southwest	
<b>Ambulatory clinic schedules</b>						
No. of respondents	492	121	118	114	139	
Patient visits via telehealth	400 (81.3)	103 (85.1)	88 (74.6)	93 (81.6)	116 (83.5)	.164
Limited clinic/ambulatory centers hours	350 (71.1)	90 (74.4)	82 (69.5)	83 (72.8)	95 (68.3)	.692
Regular clinic/ambulatory centers hours	53 (10.8)	8 (6.6)	18 (15.3)	10 (8.8)	17 (12.2)	.143
No clinic and no telehealth	15 (3)	5 (4.1)	2 (1.7)	4 (3.5)	4 (2.9)	.727
<b>OBL</b>						
No. of respondents	203	46	54	46	57	
Closed	104 (51.2)	30 (65.2)	17 (31.5)	37 (80.4)	20 (35.1)	<.001
Offloading volume from the hospital	32 (15.8)	4 (8.7)	15 (27.8)	5 (10.9)	8 (14)	.036
Performing procedures as usual	18 (8.9)	3 (6.5)	8 (14.8)	0	7 (12.3)	.047
Performing urgent procedures only	82 (40.4)	13 (28.3)	31 (57.4)	9 (19.6)	29 (50.9)	<.001
<b>Cases currently treated at OBL</b>						
Critical limb ischemia	87 (42.9)	12 (26.1)	33 (61.1)	9 (19.6)	33 (57.9)	<.001
Dialysis access maintenance	81 (39.9)	13 (28.3)	36 (66.7)	6 (13)	26 (45.6)	<.001
Wound care	32 (15.8)	7 (15.2)	10 (18.5)	1 (2.2)	14 (24.6)	.018
Venous	23 (11.3)	6 (13)	11 (20.4)	0	6 (10.5)	.015
<b>Vascular laboratory</b>						
No. of respondents	472	120	111	111	130	
Open as usual	49 (10.4)	8 (6.7)	20 (18)	4 (3.6)	17 (13.1)	.002
Urgent outpatient studies	351 (74.4)	85 (70.8)	88 (79.3)	86 (77.5)	92 (70.8)	.303
Urgent inpatient studies	235 (49.5)	60 (50)	41 (36.9)	73 (65.8)	61 (46.9)	<.001
Closed	40 (8.5)	15 (12.5)	5 (4.5)	7 (6.3)	13 (10)	.12
OBL, Outpatient based laboratory. Values are number (%).						

at that time and thus limited the detail surrounding cancelled "elective" cases. This language will be included in future survey design.

The survey evaluated the impact of COVID-19 on vascular surgeons practicing in the United States at a single point in time. Our data show that vascular surgical care and surveillance has been restricted, and will likely continue to be limited as the COVID-19 pandemic continues. The long-term effects on vascular patients are unknown, and the greater need for preserving public health resources to the population remains a priority. The unknown sequelae of unanticipated delays on vascular surgical care and patient outcomes prompted the creation of the Vascular Surgery COVID-19 Collaborative to prospectively follow these impacts.<sup>18</sup>

## CONCLUSIONS

The COVID-19 pandemic led to dramatic changes to the delivery of vascular surgical care in the United States during the period of April 14 to 24, 2020 and regional variations in practice patterns were identified. These included significant cancellations of elective surgical

cases, reduction in outpatient visits, and lower use of the vascular lab. Vascular care was continued via telemedicine and for cases favoring life over limb.

## AUTHOR CONTRIBUTIONS

Conception and design: NM, RF, MW, AJ, SS

Analysis and interpretation: NM, KW, RM, SC, SS

Data collection: SS

Writing the article: NM, KW, RF, MW, RC, MS, SS

Critical revision of the article: NM, KW, RF, MW, AJ, RC, DC, SC, MS, SS

Final approval of the article: NM, KW, RF, MW, AJ, RC, DC, SC, MS, SS

Statistical analysis: SS

Obtained funding: Not applicable

Overall responsibility: SS

## REFERENCES

1. COVIDSurg Collaborative. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. *Br J Surg* 2020 May 12. [Epub ahead of print].
2. American College of Surgeons. COVID-19: Recommendations for Management of Elective Surgical Procedures.



- Available at: [www.facs.org/about-acscovid-19/information-for-surgeons/elective-surgery](http://www.facs.org/about-acscovid-19/information-for-surgeons/elective-surgery). Accessed April 27, 2020.
- American College of Surgeons. COVID-19 guidelines for triage of vascular surgery patients. Available at: [www.facs.org/covid-19/clinical-guidance/elective-case/vascular-surgery](http://www.facs.org/covid-19/clinical-guidance/elective-case/vascular-surgery). Accessed April 27, 2020.
  - Stahel PF. How to risk-stratify elective surgery during the COVID-19 pandemic? *Patient Saf Surg* 2020;14:8.
  - Ross SW, Lauer CW, Miles WS, Green JM, Christmas AB, May AK, et al. Maximizing the calm before the storm: tiered surgical response plan for novel coronavirus (COVID-19). *J Am Coll Surg* 2020;230:1080-91.e3.
  - Forbes TL. Vascular surgery activity condition is a common language for uncommon times. *J Vasc Surg* 2020 Apr 30. [Epub ahead of print].
  - Hemingway JF, Singh N, Starnes BW. Emerging practice patterns in vascular surgery during the COVID-19 pandemic. *J Vasc Surg* 2020 Apr 30. [Epub ahead of print].
  - Mirza AK, Manunga J, Skeik N. Indirect casualties of COVID-19: perspectives from an American vascular surgery practice at a tertiary care centre. *Br J Surg* 2020;107:e246.
  - Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377-81.
  - Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform* 2019;95:103208.
  - Day J, MacMahon A, Roberts MM, Drakos MC, Johnson AH, Levine DS, et al. Perspectives from the foot and ankle department at an Academic Orthopedic Hospital during the surge phase of the COVID-19 pandemic in New York City. *Foot Ankle Int* 2020;41:881-4.
  - Wong TY, Bandello F. Academic ophthalmology during and after the COVID-19 Pandemic. *Ophthalmology* 2020 Apr 21. [Epub ahead of print].
  - Aminian A, Kermansaravi M, Azizi S, Alibeigi P, Safamanesh S, Mousavimaleki A, et al. Bariatric surgical practice during the initial phase of COVID-19 outbreak. *Obes Surg* 2020 Apr 20. [Epub ahead of print].
  - Fontanella MM, De Maria L, Zanin L, Saraceno G, Terzi di Bergamo L, Servadei F, et al. Neurosurgical practice during the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic: a worldwide survey. *World Neurosurg* 2020 Apr 27. [Epub ahead of print].
  - Tuech JJ, Gangloff A, Di Fiore F, Michel P, Brigand C, Slim K, et al. Strategy for the practice of digestive and oncological surgery during the Covid-19 epidemic. *J Vasc Surg* 2020;157:S7-12.
  - CDC. Previous U.S. COVID-19 case data. Available at: [www.cdc.gov/coronavirus/2019-ncov/cases-updates/previouscases.html](http://www.cdc.gov/coronavirus/2019-ncov/cases-updates/previouscases.html). Accessed July 13, 2020.
  - Peters AW, Chawla KS, Turnbull ZA. Transforming ORs into ICUs. *N Engl J Med* 2020;382:e52.
  - Mouawad NJ, Cuff RF, Hultgren R, Chuen J, Galeazzi E, Wohlauer M. The Vascular Surgery COVID-19 Collaborative (VASCC). *J Vasc Surg* 2020;72:379-80.

Submitted Jun 4, 2020; accepted Aug 2, 2020.

*Additional material for this article may be found online at [www.jvascsurg.org](http://www.jvascsurg.org).*

**SUPPLEMENTARY INFORMATION (online only).****Society for Vascular Surgery Wellness Task Force  
Pandemic Practice, Anxiety, Coping and Support Survey  
for Vascular Surgeons****Version: Impact on Practice the United States.**

1. How many years have you been in practice?
  - 0-10 years
  - 11-20 years
  - >20 years
2. What is the practice type were you work primarily?
  - Academic
  - Multi-specialty
  - Community
  - Solo
  - Veterans Affairs or Government Run
  - Outpatient Based Laboratory (OBL) practice only
  - Dedicated Outpatient Vein Practice Only
3. What is your gender?
  - Male
  - Female
  - Prefer not to say
4. In which state or territory do you primarily practice?
5. What race do you consider yourself to be?
  - American Indian or Alaskan Native
  - Asian
  - Black or African American
  - Native Hawaiian or other Pacific Islander
  - White
  - Mixed Race
  - Prefer not to say
  - Other
6. Have you operated on a patient with confirmed infection COVID-19?
  - Yes
  - No
  - I don't know
7. Which of the following precautions did you use when operating on a patient with confirmed infection COVID-19? (Select all that apply)
  - Intubation was off-site
  - The surgical team waited outside the operating room while the patient was intubated
  - I used an N95 mask during the operation
  - I used a Powered Air purified Respirator
8. Have you placed central venous access (including hemodialysis catheter) on a patient with COVID-19?
  - Yes
  - No
9. Have you placed central venous access (including hemodialysis catheter) on a patient with COVID-19?
  - Yes
  - No
10. Was the PPE provided for you during line placement in a patient with COVID-19 adequate?
  - Yes
  - No
11. Did you operate on or perform a procedure on patient who was later discovered to have a COVID-19 infection?
  - Yes
  - No
12. How was your exposure to a patient infected with COVID-19 handled?
  - Continued to work
  - Self-quarantine
  - I was tested for COVID-19
  - Other
13. Feel free to share more on "other" post-exposure measures taken after operating/performing a procedure on someone with COVID-19
14. Have you tested positive for COVID-19?
  - Yes
  - No
  - Prefer not to say
  - I have not been tested
15. Are you considered at "high" risk for COVID-19 infection?
  - Yes
  - No
16. 28. Do you have an institutional leadership position (e.g. program director, vascular lab director, section head, division head, department chair)?
  - Yes
  - No
17. Changes in Vascular Surgery Practice
18. What hospital type where you work primarily? (Urban refers to an area with more than 50,000 people and rural with less than 50,000 people)
  - Urban, Teaching
  - Urban, Non-Teaching
  - Rural Teaching
  - Rural Non-Teaching
19. What is the size of the hospital were you work primarily?
  - < 50 beds
  - 50-99 beds
  - 100-200 beds
  - 201-300 beds
  - 301-400 beds
  - >400 beds
  - I do not work at a hospital
  - Don't know
20. Do you practice at more than one hospital?
  - Yes
  - No
  - Not applicable to my practice

21. At the primary hospital where you work, the following is true (Select all that apply)
- There are AVAILABLE beds in the ICU
  - ICUs are full, patients are boarding in the emergency department
  - ICUs are full, patients are boarding in the PACU and operating rooms
  - ICUs are full, patients are boarding in hallways other than the emergency department, PACU, and operating rooms
  - Not applicable to my practice
22. The primary hospital or facility where you work has (Select all that apply)
- COVID-19 Operating Room protocols
  - Adheres to ACS/SVS guidelines for allowable surgeries during COVID-19
  - Adequate personal protective equipment (PPE)
  - Pre-operative testing of patients for COVID-19
23. Are all elective surgical procedures cancelled?
- Yes
  - No
24. Which of the following ELECTIVE surgical procedures are still taking place? (Select all that apply)
- Aortic Surgery
  - Carotid Surgery
  - Dialysis Access
  - Lower extremity revascularization
  - Venous Procedures
25. Changes in call schedule and re-deployment
26. Has your call schedule changed over the last month compared to pre-COVID?
- Yes
  - No
  - Not applicable to my practice
27. Which of the following do you think best represent your call schedule in the last two weeks? (Select all that apply)
- Less call days
  - More call days
  - Same overall number of call days but changed in distribution
28. Have you been asked to assist in duties other than those as a vascular surgeon?
- Yes
  - No
29. Which other duties have you been asked to assist in? (Select all that apply)
- Managing ICU
  - Taking shifts to assist the ICU teams in placing lines
  - Seeing the patients in the ED
  - Covering other surgery services
  - Covering other medical services
  - Triage of our patient transfers to field hospitals or clinics
  - Administrative tasks (i.e. PPE management)
  - Additional educational or research responsibilities
  - Other
30. Please share details regarding changes in the call schedule or other responsibilities when not explicitly on call for vascular surgery
31. Changes in other aspects of vascular surgery practice
32. What type of ambulatory and clinic services are you currently providing (select all that apply)
- Regular clinic/ambulatory center hours
  - Limited clinic/ambulatory center hours
  - Patient visits via telehealth
  - No Clinic and no telehealth
33. Are you participating in the delivery of any outpatient care for vascular surgery patients?
- Yes
  - No
34. How are you participating in the delivery of any outpatient care for vascular surgery patients? (Select all that apply)
- Audio/video telehealth
  - Select patients in clinic
  - Regular Clinic/Ambulatory centers hours
35. Is your surgical center OBL open?
- Yes
  - No
  - We do not have an OBL
36. In what capacity is your OBL open? (Select all that apply)
- Performing procedures as usual
  - Performing urgent procedures only
  - Offloading volume from the hospital
  - Other
37. What type of cases are you currently treating in your OBL?
- Critical limb ischemia
  - Dialysis access maintenance
  - Wound Care
  - Venous Procedures
  - Other
38. Please feel free to provide more info on the other cases you are currently treating in your OBL or how your OBL capacity has changed

39. Is your vascular lab open?

- Yes
- No
- We do not have a vascular lab

40. In what capacity is your vascular lab open? (Select all that apply)

- Performing studies as usual
- Performing urgent outpatient referrals

○ Performing urgent inpatient studies

○ Other

41. Please provide more info on the other capacity your vascular lab is open?

42. Final thoughts

43. Feel free to share any additional information about your experience operating or performing procedures on patients with confirmed or suspected COVID-19.

**Supplementary Table (online only).** Multimodal survey dissemination, potential audience, and estimated response rate

SVS and affiliated organizations	Date of dissemination	Potential audience
SVS Email list <sup>a</sup>	4/14/2020	3528
SVS Connect	4/17/2020	1203
Vascular Specialist Magazine <a href="https://vascularspecialistonline.com/svs-needs-assessment-survey-evaluating-impact-of-covid-19-on-vascular-surgery/">https://vascularspecialistonline.com/svs-needs-assessment-survey-evaluating-impact-of-covid-19-on-vascular-surgery/</a>	4/16/2020	399
Other outreach platforms		
Vascular Surgeons COVID-19 WhatsApp	4/14/2020	256
Vascular Low Frequency Disease Consortium mailing	4/15/2020	30
VA Vascular Surgeons	4/15/2020	97
Social media outreach		
Vascular SVS @VascularSVS	4/16/2020	5913
Vascular Specialist Online @VascularOnline	4/16/2020	351
Audible bleeding @Audiblebleeding	4/16/2020	985

SVS, Society for Vascular Surgery.

<sup>a</sup>On 4/14/2020 emails were sent to 3528 recipients; 3525 were received (3 bounced). Of those received 1866 were opened (52.9%) and 381 accessed the survey directly from the email link. On 4/23/2020 a reminder email was sent to the same list. Of these, 1263 were opened (35.8%) and 134 accessed the survey directly from the email, suggesting that 515 respondents were reached via the SVS email list. This accounts for approximately 16.5% of all emails opened.