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Co-Operative Vascular Intervention Disease (COVID) Team of Greater Philadelphia

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ABSTRACT

We established the Co-Operative Vascular Intervention Disease (COVID) Team of Greater Philadelphia because national guidelines may not apply to different geographic areas of the United States owing to varying penetrance of the virus. On April 10, 2020, a 10-question survey regarding issues and strategies dealing with COVID-19 was e-mailed to 58 vascular surgeons (VSs) in the Greater Philadelphia area. Fifty-four VSs in 18 surgical groups covering 28 hospitals responded. All groups accepted transfers because of continued availability of intensive care unit beds. Thirteen groups were asked to ‘redeploy’ if the need arose to function outside of the usual duties of a VS. None imposed age restrictions regarding older VSs continuing clinical hospital work. The majority restricted noninvasive vascular laboratory studies to those studies for which findings might mandate intervention within 2 or 3 weeks, restricted dialysis access operations to urgent revisions of arteriovenous fistulas or grafts that were failing or had ulcerations, converted from in-person to telemedicine clinical interactions, and experienced moderate-severe anxiety or fear about personal COVID-19 exposure in the hospital. The majority of VSs in the Philadelphia area dramatically adjusted their clinical practices before the COVID-19 crisis reached peak levels experienced in other metropolitan areas. (J Vasc Surg 2020;72:1178-83.)

Keywords: Covid virus affecting vascular surgeons

COVID-19, also called coronavirus disease, has spread rapidly through the world and the United States with high infection and mortality rates. The Society for Vascular Surgery (SVS) recently made a concerted national effort to better educate its members about the disease. We established the Co-Operative Vascular Intervention Disease (COVID) Team of Greater Philadelphia because we believe vascular surgeons (VSs) should be the driving force in decision making concerning vascular disease during this crisis and national guidelines may not apply to different geographic areas of the United States owing to varying penetrance of the virus. The function of the team is to gather opinions and strategies of VSs in the Philadelphia area to address the impact of COVID-19.

METHODS

On April 10, 2020, a 10-question survey was e-mailed to 58 VSs in the Greater Philadelphia area regarding issues and strategies for dealing with the coronavirus. Response time was limited to 3 days so results could be analyzed at a specific point in time and re-examined in the future as virus penetrance changed. Responses were classified according to individual VSs or VS groups, depending on the question. Surgeons were identified by contacting the chief of each vascular section or division and asking for e-mail contacts for each member of the group. The Greater Philadelphia area was loosely defined as those medical centers in the city boundaries of Philadelphia with inclusion of medical centers within approximately a 1-hour drive of the city. This area included northeastern, eastern, and southeastern Pennsylvania and southern New Jersey. Delaware and central Pennsylvania and central New Jersey were not included. We did not want to place a strict mileage definition of the Philadelphia area because some hospitals immediately beyond any defined distance might refer patients to hospitals closer to Center City Philadelphia and surrounding academic centers. Questions were scored according to yes/no responses or choosing an answer among three to five answers provided for each question.

RESULTS

At the time of the survey, 60% (248/410) of intensive care unit (ICU) beds in one of the major health care systems in the Philadelphia area, namely, the University of Pennsylvania Health System consisting of seven hospitals, were occupied with COVID-19 patients. Fifty-four VSs functioning as 18 VS groups covering 28 hospitals in the Greater Philadelphia area responded. All 18 VS groups (Table I, six questions) accepted transfers at the time of the survey because of continued
availability of ICU beds. Thirteen groups were asked to ‘redeploy’ if the need arose to function outside of the usual duties of a VS. Seven groups needed special permission from the chairman of surgery or other supervisor to schedule urgent or emergent surgery that was not required before the pandemic. Only one group (private practice) had an office-based laboratory where endovascular arterial procedures were performed. Because of lack of a large sample size, willingness to allow other VSs to perform procedures at these non-hospital-based facilities could not be determined. Of the 15 university/hospital-employed groups, none expected >50% salary reduction, whereas all 3 private practice groups had already experienced this drastic decrease in income. None of the 18 groups restricted older VSs from performing clinical duties in the hospital.

Among the 54 VSs who responded to the survey (Table II, four questions), elective repair of an asymptomatic abdominal aortic aneurysm (AAA) in a good-risk 75-year-old patient was recommended at a median diameter of 6.0 cm (average, 6.35; range, 5.0-8.0) for endovascular aneurysm repair (EVAR) compared with 6.5 cm (average, 6.53; range, 5.5-9.0) if open repair was necessary. Seventy-eight percent (42) restricted noninvasive vascular laboratory (NIVL) studies to those studies for which findings might mandate intervention within 2 or 3 weeks, such as duplex ultrasound surveillance of a known stenotic lower extremity arterial bypass. Twenty-percent (11) continued to perform routine follow-up and diagnostic NIVL studies (essentially no change) and 2% (1) closed their laboratory. Sixty-seven percent (36) restricted dialysis access operations to urgent revisions of arteriovenous fistulas (AVFs) or grafts that were failing or for impending hemorrhage due to skin ulcerations overlying the conduit. Seventy-eight percent (42) converted from in-person office visits to telemedicine clinic interactions. Of the 39 VSs at teaching hospitals, all had transitioned to digital platforms for educational conferences. Eight (21%) responded that the number of weekly conferences had decreased at the time of the survey, 14 (35%) responded that conferences had increased, and 17 (44%) responded that there was no change. Last, 63% (34) of VSs experienced moderate or severe anxiety or fear about personal COVID-19 exposure in the hospital.

**DISCUSSION**

COVID-19, otherwise known as coronavirus disease, is a novel coronavirus first detected in Wuhan, China, in December 2019. The number 19 refers to the fact that the disease was first detected in 2019, although the pandemic outbreak occurred in early 2020. The disease quickly spread around the world, with the largest case-load occurring in the United States.

We created the Co-Operative Vascular Intervention Disease (COVID) Team of Greater Philadelphia for two reasons. First, we believed VSs should be the driving force in decisions regarding vascular issues during this crisis. VSs best understand the complex decision-making
regarding emergent, urgent, and nonelective interventions and the type of interventions most appropriate to treat vascular disease. For example, VSs are best suited to determine timing of elective first-time AVFs and grafts if a patient already has a functioning tunneled dialysis catheter, although a discussion with the patient’s nephrologist is appropriate. VSs can best determine the timing for repair of an asymptomatic AAA during the COVID-19 crisis based on the patient’s risk factors, aneurysm diameter and morphology, and potential need for an ICU bed. VSs possess the judgment necessary to determine whether endovascular procedures might be preferable to standard open surgery in the context of the pandemic. Second, national guidelines proposed by the SVS and other societies may not be appropriate for different geographic areas of the United States because of varying penetrance of the virus and clinical resource saturation. At the time of the survey in mid-April 2020, 60% (248/410) of ICU beds in the University of Pennsylvania Health System (seven hospitals) were occupied with COVID-19 patients. This percentage was significantly lower than experienced in other major metropolitan areas, such as New York City and Seattle, Washington. The impact of the virus at local and regional levels might affect attitudes and strategies of VSs practicing in those areas more than national data.

We wished to examine the availability of ICU beds in hospitals in the Philadelphia area at varying times of

| Question | Yes, No (%) | No, No. (%) |
|----------|-------------|-------------|
| 1. Appropriateness of diagnostic tests and surgery in the current climate | | |
| a. NIVL: Does your hospital or practice | 11 (20) | – |
|   i. continue to perform routine follow-up and diagnostic studies (essentially no change)? | | |
|   ii. perform only studies whose findings potentially mandate intervention within the next few weeks (acute problems: DU surveillance of known potentially failing vein bypass)? | 42 (78) | – |
|   iii. not perform noninvasive laboratory studies anymore? | 1 (2) | – |
| b. Dialysis access: Do you perform | | |
|   i. new AVFs/grafts (essentially no change)? | 5 (9) | – |
|   ii. only new AVFs/grafts for patients already on dialysis and catheter dependent? | 13 (24) | – |
|   iii. only urgent interventions for poorly functioning AVFs/grafts already in place or for ulcerations with potential hemorrhage? | 36 (67) | – |
| c. Elective repair of AAA: At the present time, at what diameter AAA would you recommend intervention within the next 2-3 weeks in a good-risk 75-year-old patient? | Median, 6.0 cm (average, 6.35; range, 5.0-8.0) | 3 |
|   i. If I could do it with EVAR? | | |
|   ii. If I had to perform open repair requiring ICU bed at least 1-2 nights? | Median, 6.5 cm (average, 6.53; range, 5.5-9.0) | 4 |
| 2. Education: Do you have trainees? | 39 (72) | 15 (28) |
|   a. Do you now use social media for conferences? | 39 (100) | 0 (0) |
|   b. Has the frequency of conferences decreased? | 8 (21) | – |
|   Stayed the same? | 17 (44) | – |
|   Increased? | 14 (35) | – |
| 3. Outpatient clinic visits | | |
|   a. Do you evaluate most clinic patients in person? | 11 (20) | – |
|   b. Do you evaluate most clinic patients using telemedicine? | 42 (78) | – |
|   c. Have you closed your clinic? | 1 (2) | – |
| 4. Fear: How much anxiety and fear do you have about going into your hospital? | | |
|   a. Minimal | 20 (37) | – |
|   b. Moderate | 29 (54) | – |
|   c. A lot! | 5 (9) | – |

AAA, Abdominal aortic aneurysm; AVF, arteriovenous fistula; DU, duplex ultrasound; EVAR, endovascular aneurysm repair; ICU, intensive care unit; NIVL, noninvasive vascular laboratory. 

Table II. Individual vascular surgeons (VSs; 54)
the coronavirus crisis. If certain hospitals were over-
whelmed by the virus and could not accept transfers, such as ruptured AAAs or other vascular patients requiring an ICU bed, other hospitals might have available ICU beds and be able to accept those patients. By establishing lines of communication among VS groups, the hospitals accepting transfers could be made known to the vascular community. Because of the relatively low penetrance of the virus at the time of the survey, all 18 VS groups continued to accept emergency trans-
fers because of continued availability of ICU beds. We did not want to wait until our area became so over-
whelmed that our collective response was too little too late.

Hospital administrators asked the majority (13) of VS groups to redeploy to perform duties other than the usual functions of a VS if the need arose because of an overwhelming number of COVID-19 patients. These duties included placing central venous or peripheral arterial lines and caring for patients in the emergency department or ICU. Hospital administrators asked 11 of the 13 groups to function as “first-line” responders, mean-
ing that VSs were as likely as general surgeons or other specialty surgeons to be called to help deal with the crisis. Hospital administrators asked 2 of the 13 groups to serve as “backup” responders only if medical and sur-
gical residents, other attending surgeons, anesthesiolo-
gists, and ICU attending physicians were unavailable. Several VSs expressed the concern that if they were first-line responders and became infected with the virus, they might not otherwise be available to treat true vascular emergencies.

Eleven of the 18 VS groups were empowered to schedule urgent or emergent vascular surgery without permission by the chairman of surgery or other supervi-
sors. The argument to allow VSs to schedule cases without oversight is because they understand when ur-
gent intervention is indicated, such as for lower extremity rest pain or tissue loss, failing lower extremity bypass, or symptomatic carotid disease. However, the counterargu-
ment of having a chairman of surgery oversee these de-
cisions may be reasonable if there is resource saturation such that triage is necessary. Our survey showed that a clear majority of VSs did not need this type of permission. Our data would support those VSs needing permission to approach their chairman and inform that most med-
cal centers do not have this requirement.

Only one (private practice) of the 18 groups operated an office-based laboratory that performed arterial endovas-
cular interventions in a non-hospital-based facility. There-
fore, we could not gather reliable data concerning willingness of VSs at office-based laboratories to allow other interventionalists to perform procedures at their facility.

We questioned the financial impact of the virus on VS practices. Of the 15 university/hospital-employed groups, none expected more than a 50% salary reduction, whereas all 3 private practice groups experienced this in-
come reduction by the time of the survey. This reduction was largely due to cancellation of all elective surgical and endovascular interventions. The increasing penetration of the hospital-employed model of practice will likely accelerate as a result of the pandemic.

None of the 18 groups imposed age restrictions on older VSs performing hospital-based duties. Although increased age has clearly been shown to be a significant risk factor in acquiring the virus and experiencing worse symptoms with worse outcomes than younger members of the population, none of the groups adopted these pre-
cautions. This attitude “Do as I say, not as I do” could prove harmful to older VSs as significant death rates have already been documented among health care pro-
viders. The mantra “stay at home!” does not seem to apply to older VSs and may not apply to older health care providers either.

Of the 54 VSs who answered the survey, elective repair of AAA in a good-risk 75-year-old patient was recom-
mended at a median diameter of 6.0 cm (average, 6.35; range, 5.0-8.0) if EVAR could be performed compared with 6.5 cm (average, 6.53; range, 5.5-9.0) if open repair was necessary. Of note, only three VSs responded that they would not recommend repair of an asymptomatic aneurysm regardless of size even if EVAR was possible, and four VSs would not recom-
mend repair regardless of size when only open repair was possible. The recommended median diameter
>6.5 cm in this survey for repair of asymptomatic AAAs if possible only with open surgery was in line with SVS COVID-19 toolkit guidelines.1 However, the sur-
vey revealed that VSs in the Philadelphia area recom-
mended elective EVAR repair of AAA at smaller median and average diameters than the SVS guidelines suggested. This disparity may be accounted for by the relatively low penetrance of the virus and the high avail-
ability of ICU beds in the Philadelphia area at the time of the survey. Many of the individual VS’s opinions fell in line with other members of their own group, demon-
strating a similar philosophy regarding indications for elective AAA repair. At one teaching hospital, all three VSs maintained a uniform aggressive attitude and rec-
ommended endovascular or open intervention for AAAs >5.5 cm. A few miles away, a teaching hospital with three VSs maintained a much more conservative attitude. Two of the surgeons recommended EVAR when the AAA was >7.5 cm and open repair for aneu-
rysms >8.5 cm, whereas the third surgeon would not recommend elective repair regardless of size or type of repair. Clearly, there are disparate opinions regarding the propriety of elective cases and what defines an elec-
tive case at this time.

Seventy-eight percent (42/54) of VSs restricted NIVL
studies to those studies for which findings might
mandate intervention within 2 or 3 weeks. For example, duplex ultrasound surveillance might be recommended for a patient with a known stenosis of a failing lower extremity bypass that could potentially be treated with a simple endovascular intervention to maintain bypass patency. If prophylactic intervention was postponed and the bypass thrombosed, complicated thrombolytic treatment or a new bypass might be required. Continuing routine NIVL studies as usual would unneccessarily expose patients and vascular laboratory technologists to the virus, especially considering the close contact required to perform noninvasive vascular studies.

Sixty-seven percent (36/54) restricted dialysis access operations to urgent revisions of AVFs or grafts that were failing or for impending rupture due to ulcerations overlying the conduit. Some VSs continued to place new AVFs or grafts in patients with functioning tunneled dialysis catheters (24% [13]) and in patients not yet on dialysis (9% [5]). There are two concerns with performing purely elective AVFs and grafts during this pandemic. Patients with chronic renal failure are immunocompromised and therefore at higher risk of viral infection coming into the hospital for surgery and being exposed to COVID-19 carriers. Health care providers, including VSs, are also at greater risk of contracting the infection by exposing themselves to a population that has a higher prevalence of the disease.

Seventy-eight percent (42/54) of VSs had converted from in-person to telemedicine clinic interactions. Avoiding direct patient contact in the office setting is advantageous for patients, office staff, NIVL technologists, and VSs. Even though the penetrance of COVID-19 in the Greater Philadelphia area was lower than in some other metropolitan areas, the majority of VSs quickly adopted this telemedicine strategy. The disadvantage of this approach is the inability to perform a physical examination and in some cases obtain an NIVL study, which may lead to less accurate diagnoses or need for more urgent interventions. It has been noted that there has been an increase in non-COVID-19 cardiovascular mortality in the last 2 months, which may reflect the risk of delayed care.

Thirty-five percent (14/39) of VSs at training programs believed the number of weekly conferences increased since the onset of the crisis, 21% (8/39) believed the number had decreased, and 44% (17/39) believed the number remained the same. Academic VSs realized that continuing to hold teaching conferences seated together in one room was hazardous and quickly converted to digital platforms as a means to continue academic conferences. The fact that teaching conferences did not dramatically decrease during the beginning of the crisis is testament to the flexibility of VSs addressing this problem.

Last, 63% (34/54) of VSs experienced moderate or severe anxiety or fear regarding personal COVID-19 exposure in the hospital. VSs are likely to have a high rate of unease and apprehension because of concern not only for themselves but also for their family. VSs and other health care providers should acknowledge the emotional impact of dealing with these critically ill patients and understand that part of their concern is knowing they might become infected with COVID-19 the next time they enter the hospital.

CONCLUSIONS
The majority of VSs in the Philadelphia area dramatically adjusted their clinical practices before the COVID-19 crisis reached peak levels experienced in other metropolitan areas. The survey revealed only a modest shift in VSs’ attitudes regarding recommendations for elective repair of AAAs. Older VSs have not adopted precautionary stay-at-home recommendations urged for elderly members of the general population. We will monitor evolving practice strategies as virus penetrance changes.

AUTHOR CONTRIBUTIONS
Conception and design: KC
Analysis and interpretation: KC, MD, KM, KV, DT
Data collection: KC
Writing the article: KC
Critical revision of the article: KC, MD, KM, KV, DT
Final approval of the article: KC, MD, KM, KV, DT
Statistical analysis: Not applicable
Obtained funding: Not applicable
Overall responsibility: KC

REFERENCES
1. COVID-19 guidelines for triage from vascular patients. Available at: https://www.facs.org/covid-19/clinical-guidance/elective-case/vascular-surgery. Accessed April 10, 2020.
2. McNamara A. Why are non-COVID related deaths on the rise?. Available at: https://www.sciencefocus.com/news/why-are-non-covid-related-deaths-on-the-rise/. Accessed April 10, 2020.

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APPENDIX.
Co-Operative Vascular Intervention Disease (COVID)
Team of Greater Philadelphia.
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Lankenau/Riddle Hospital: Alex Uribe, Vince DiGiovanni, Robert Meisner
Lehigh Valley Hospital: Chris Werter, James Guzzo, Mila Ju, James McCullough
Phoenixville Hospital: John Flanagan
Paoli/Bryn Mawr/Chester County Hospitals: Sean Ryan, Gerry Patton, Dan Hayes
Pennsylvania Hospital/Chestnut Hill: Keith Calligaro, Matthew Dougherty, Douglas Troutman
Pottstown Hospital: Edward Pavillard
Reading Hospital: Ali Amin, Hong Zheng, Robert Luo, Jim Coffey, Kathleen Lamb
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