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Research Article

Development and Implementation of a Vascular Acute Care Surgery Center Model: Lessons Learned and Challenges Faced

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Abstract

Objectives

The development of acute care surgery has improved the quality of care for patients in the field of general surgery. Increases in the number and complexity of acute, severe vascular conditions, such as ALI and R-AAA, have raised the point that similar programs to establish acute care vascular centers may provide similar benefits. A center specialized in high-risk and acute vascular surgery care may offer improvements in the regional and individual management of these potentially deadly conditions. Our institution has created a Vascular Acute Care Surgery (VACS) Center to treat these pathologies, including developing rapid transfer strategies and streamlined treatment protocols. The island of Puerto Rico faces particular challenges in resource distribution and the availability of local expertise. This study aims to review the steps and challenges to develop a VACS Center in Puerto Rico.

Methods

The VACS Center included a transfer center to facilitate physician-to-physician communication, expedite patient transfers, implementation of treatment protocols to ensure the quality of care, and report to the Vascular Quality Improvement (VQI). Evaluation, optimization and re-organization of resources (Instruments, materials and personal) required for a continuous 24/7/365 days a year service. A retrospective analysis was conducted of all the patients received to our institution from September 2019 to September 2020. Patients were categorized based on indications for transfer and the need for operative management. Patients' comorbidities, diagnoses, and procedures were analyzed and recorded.

Results

A total of 293 patients were received at the center and 39% (75) were transferred from 18 municipalities across the island. The three most common indications for transfer were acute limb ischemia, chronic limb threatening ischemia, and aortic pathologies. The most common procedures performed were lower extremity endovascular revascularization, extremity bypass, and open thrombectomy. The average age was 70 years old with 46% being male. The most common comorbidities were Hypertension (80%) and Diabetes Mellitus (47%). There was an increase of 5 times in patients with acute limb ischemia (ALI) when compared to the period of September 2018 to September 2019.

Conclusion

Limited data is available of other centers specialized in acute vascular pathologies in Puerto Rico. Further collaboration from other institutions and hospitals is paramount to our mission as a VACS center. Ease of transfer, 24/7 service availability, and a marketing campaign have been vital points for the center's success. The increasing amount and complexity of patients requiring emergent vascular intervention in Puerto Rico far exceeds the number of vascular surgeons available and committed to our mission of increasing the availability and quality of vascular care.

Keywords: Acute care; Acute limb ischemia; Vascular surgery

Introduction

In the early 2000s, there was an increase in acute general surgery pathologies that led to the subspecialty development known as acute care surgery [1]. The development of acute care surgery has improved the quality of care for patients in the field of general surgery [1]. Similarly, we have experienced an increase in severe life-threatening vascular conditions, such as acute limb ischemia and ruptured aortic aneurysms that require an emergent vascular intervention to obtain satisfactory outcomes [2]. This phenomenon has raised the possibility that a similar program to establish acute care vascular sub-specialty centers may significantly benefit patient outcomes [1]. The development of a Vascular Acute Care Surgery (VACS) center represents an effort to improve healthcare access and continuity of care to reduce the morbidity and mortality associated with these pathologies [3].

The increased incidence/prevalence of cardiovascular diseases has raised concerns about the existing health care system's ability to provide appropriate urgent and emergent care in vascular surgery [1]. There is a shortage of on-call vascular surgeons to cover acute pathologies, and many younger surgeons have chosen to specialize in outpatient care [4]. Also, we already know that these pathologies

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are time-sensitive and frequently require high-intensity perioperative care [5]. The development of specified VACS centers to manage these conditions is imperative to ensure the best outcomes.

Every day, our practice cares for patients with advanced vascular pathologies. The reasons for this could be poor recognition of vascular pathologies, resulting in delayed or missed opportunities for diagnosis and treatment by primary care physicians. Poor health literacy, medication adherence, and an aging population with chronic predisposing conditions all contribute to the rising tide of vascular disease [5]. Our current system is poorly equipped to address this challenge.

After Hurricane Maria struck Puerto Rico in 2017, the island suffered a massive efflux of doctors to the mainland United States, exacerbating a health crisis. Currently, the island has ten trained vascular surgeons for a population of 3.5 million that is one vascular surgeon for every 350,000 patients. Recent data suggest that 1.4 vascular surgeons are needed for every 100,000 people [6]. In 2007, the population data in the United States of America (USA) estimated there are 2875 vascular surgeons, or approximately 115,564 people per active vascular surgeon (6). These shortfalls in existing vascular expertise and the aging population in USA, provide a strong impetus to develop new models for handling the most severe conditions in the most severely ill patients. This study aims to present how our center was created, the lessons learned, and the challenges faced, in addition, to presenting our experience during the first year, including the patients treated and procedures performed.

Methodology (IRB approval number: 1912026348)

The VACS center's development lead by vascular surgeons, started with multiple interdisciplinary meetings, including the hospital's administrative staff, critical care physicians and general surgeons, concerning the need for a center specialized in acute vascular pathologies. Points highlighted were: the lack of vascular acute care services or non-existing VACS centers on the island, patient care benefits by centralizing care, and hospital economic benefits. Our strategy would include

1. Internal issues, including treatment pathways and protocols, resource allocation, and hospital capacity.
2. External issues, such as outreach to providers, patients, and communities; and
3. Interface issues, including awareness of outside resources' availability, and transfer access points.

Our VACS Center consists of a fully trained team composed of three board-certified vascular surgeons, on-call 24/7 with support from twenty-one surgical residents. In addition to the vascular surgeons on call, there is a team of Registered nurses, operating room technicians, vascular radiology technicians and anesthesiologist on call. This team has extensive resources, including two fully-equipped hybrid rooms, two general operating rooms, and a hospital with 400 beds and 40 ICU suites. We developed protocols to address the clinical approach to the different pathologies, ALI, ruptured abdominal aorta aneurysm and venous thromboembolism, based on The Society of Vascular Surgery, Society of Critical Care Medicine, CHEST and American College of Cardiologist guidelines. These protocols guide the team to address preoperative triage, selection of operative versus medical therapeutic pathways, management during ICU stay and postoperative management. As well as include management algorithms to enhance care uniformity and specify time-to-treatment goals for our team.

A nurse practitioner is the VACS center coordinator and plays a crucial part in developing and refining our transfer system, care protocols, and outcomes metrics collection. An admission form was created and integrated on the electronic medical record (EMR) to facilitate the data collection of specified patient factors (annex 1). This form included demographics, transfer information, and reporting data of vascular pathologies concordant with vascular quality improvement (VQI). After the center was approved by the hospital administration and resources allocated to establish the program, we followed with a massive multimedia outreach campaign. It included radio, television, magazines, and social media. The campaign was designed to be implemented in stages: the first stage focused on the southwest of the island, which covers around 1 million patients closest to our center. We planned to extend our campaign slowly across the island to include the farther northeast by the summer of 2021-2022.

Our campaign has had multiple facets: First, to educate the emergency room (ER) physicians about the availability of comprehensive services "24/7/365" – 24 hours a day, 7 days a week, and 365 days a year. Second, to inform smaller diagnostic centers and urgent care clinics on the island about the range of services offered. Third, target the vascular disease awareness among the hospital administrators. And forth, to enhance patient awareness of vascular diseases and their treatments. This program allowed us to serve patients and communities from across the island who would have otherwise received limited or no specialty care.

A survey directed to primary care and emergency room physicians was distributed to identify areas of improvement in diagnosing and managing the acute vascular disease. We had previously identified difficulties in transferring or referring patients with acute vascular pathologies, and the importance of streamlining these processes was evident in the survey responses.

One of the key factors was the implementation of a transfer-coordination call center to facilitate physician-to-physician communication. When a call is received, the on-call VACS surgeon and an accepting ER physician are called in a conference call with the transferring physician for a case discussion. Once the patient arrives at the ER, the particular protocol for each pathology is started, and the VACS team prepares for the indicated therapy.

A retrospective analysis of patients received, either by arriving from our emergency department or transferred from another facility, to our institution from September 2019 to September 2020 was completed as part of our VACS quality improvement process. Patients were categorized based on indications for transfer and the need for operative management. Patients' demographics, diagnosis, comorbidities, and procedures performed were recorded and analyzed as laid out in the SVS disease-specific guidelines. This data was compared with the same period of the year before VACS implementation focusing on the patient with the diagnosis of ALI.

Results

A total of 293 patients were treated at the VACS center, and 25% (75) were transferred from 18 municipalities of Puerto Rico (Figure 1) during the study period. The vast majority of patients were over 65-year-old (68% of the patients), 70-year-old being the average and the most prevalent gender was female (54%).

Figure 1: Location of the municipalities' transfer received in the VACS center. The Star represents the location of our institution.

Furthermore, the most common comorbidities were hypertension (80%) and diabetes mellitus (47%). The three most common pathologies encountered were acute limb ischemia, chronic limb ischemia, and aortic pathologies (Table 1).

Indications for Transfer	
Acute Limb ischemia	62
Chronic Limb Ischemia	91
VTE	45
Mesenteric Ischemia	14
Aortic Pathologies	36
Traumatic Vascular Injuries	5
Renal Artery Pathology	4
Symptomatic carotid disease	12
Other (vein)	1
Total	293

Table 1: Description of the pathologies received in VACS.

AAA: Abdominal Aorta Aneurysm, VTE: Venous Thromboembolism.

The most common procedures were lower extremity endovascular revascularization, extremity bypass, and open thrombectomy (Table 2).

Procedures	
Mesenteric Revascularization	3
Endovascular Lower extremity	
Diagnostic Arteriogram	137
TPA injection	16
Stent + Angioplasty	28
Balloon Angioplasty	18
US-guided Thrombin Injection of Pseudo aneurysm	12
Open Aortic Aneurysm Repair	5
Open Lower Extremity	
Thrombectomy	33
Bypass	22
Upper Extremity Bypass	2
Endovascular Coil Embolization	4
Aortic Repair	
Open Aortic Aneurysm Repair	5
Endovascular Abdominal Aortic Aneurysm Repair (EVAR)	11
Others Aortic Procedures	15
CEA	4
Endovascular Carotid	1
Vein procedures	6
Total	318

Table 2: Procedures Performed by VACS.

TPA: Tissue Plasminogen Activator, US: Ultrasound, CEA: Carotid Artery Endarterectomy.

There was an increase of 5 times in patients with acute limb ischemia (ALI) when compared to the period of September 2018 to September 2019 (Table 3).

Pathology	Sept 18- sept 19	Sept 19- Sept 20	Increased
Acute limb ischemia	11	60	5.45

Table 3: Comparison of patients that arrived at our institution with acute limb ischemia (ALI) in the period before and after the establishment of the center.

Discussion

The development of acute care surgery has been the product of various elements in medical education and health care [7]. Starting in the early 2000s, many general surgeons, subspecializing in minimally invasive techniques and other sub-specialties, have found the work of emergency general surgery call increasingly burdensome and disruptive of their regular practice [8]. At the same time, surgeons specializing in trauma found their work environment.

Exhausting, excessively non-operative, and challenging to combine with office hours [2]. These, combined with shortages of surgical specialists willing to attend Emergency Departments, have resulted in delays of care and inadequate specialty presence in these front-line care environments. In 2003, The American Association for the Surgery of Trauma published a proposal to rename the field of acute care surgery (ACS) and conducted studies over the next several years to evaluate this specialty's needs and appropriate role [7]. ACS would include elective and emergency general surgery, trauma surgery, and critical care.

Implementing the acute care surgery paradigm has improved the clinical system and professional outcomes in several subspecialties. Prior studies aimed to decrease the time spent from patient evaluation to intervention in the operating room. This model resulted in fewer complications, shorter length of stay, and reduced mortality [3]. It also freed specialty and sub-specialty surgeons from the associated call demands and facilitated further specialty development of expertise in new techniques and technologies. An increase in the number and complexity of acute and severe vascular conditions, such as acute limb ischemia and ruptured aortic aneurysms have raised to the point that similar programs have been established at select acute care vascular sub-specialty centers aiming to provide comparable benefits [8]. A center specializing in high-risk and acute vascular surgery care could offer improvements in the regional and individual management of these potentially deadly conditions as was seen in ACS.

There are no specific guidelines for what it means to be a center specializing in vascular pathologies [8]. Creating this center is an opportunity to define the standards of this new field. In the US, in general, the increasing numbers of vascular pathologies exceed the number of vascular surgeons available; this can be a negative aspect of the center's development [4]. Another crucial component for the

development and implementation is the financial aspect. There is evidence in the literature that the integration of protocol-driven care models, like the one in our center, can decrease the length of stay, and improve mortality and morbidity, reducing hospital costs [9].

Our population consists of older individuals with a mean age of 70 years, and more ill, 70% hypertensive, and 47% diabetic, a very different population from trauma patient whose age group are from 18-35 years old. This dictates the need for a more comprehensive, sensitive, and time-limiting approach to pathologies like Acute Limb Ischemia and a Ruptured Aortic Aneurysm. This last year (2019-2020), we have seen an increase in vascular pathologies, specifically acute limb ischemia. We can't say for sure that it's an increase in incidence, but we have been able to attend to those pathologies that were neglected or unidentified in the past. We have received over 240 vascular pathologies and performed over 300 procedures since the implementation of the center. All of this was due to educating on the availability of the service, the interdisciplinary team's work across the island and within our institution. Those results reflect the success of our center in reaching more acutely ill patients and improving the quality of their care.

The development of a VACS center was not an easy path; we faced multiple challenges during the beginning that interfered with the optimal care of our patients. One of the first challenges was presenting a financially attractive initiative to obtain financial and administrative backup from the hospital administration. We presented an initiative that would increase the number of transfers and admissions from patients around the island and a center that would improve their outcomes, decreasing morbidity and mortality. Furthermore, this is the first acute vascular center on the island, increasing the hospital's prestige and popularity.

During the process of organizing the center, we faced a lack of vascular surgeons willing to take the calls, making the process more arduous. However, we started our mission with only two vascular surgeons and the backup of general surgery residents hoping that more vascular surgeons will follow our path and expand our mission in the future. We faced delays in the transfer time and arrival of the patients to our center. Before the VACS establishment, we constantly were the second and third group of surgeons called for the patient's transfer. Our outreach program played an important role in letting every emergency department know about our 24/7 service, thus decreasing their time seeking assistance.

On multiple occasions, we received patients with an incorrect diagnosis or suboptimal initial management. This situation raised the suspicion that we are facing a lack of vascular knowledge among the primary care physicians, who frequently are the first contact. This situation was consequently reflected in the late presentation of the disease and poorer outcomes overall. The implementation of conferences and educational material directed to primary physicians will be key to aid in this problem. One of the limitations of our research is the lack of information about the timing between the arrival of the patients to the other institution and the arrival to our center. In the future a prospective cohort study can be done adding the information of the timeframe at the moment of arrival.

Along with the Vascular and Endovascular Surgery Society of Puerto Rico, a congress centered in vascular pathologies, diagnosis, and management has being provided to primary care, and emergency medicine physicians, held on the island for the last 12 years. This congress aims has shifted to educate the physicians who are the first contact for these patients, improving their diagnostic capacity and initial management skills. They will be given the tools they need to diagnose and begin therapy before transferring these patients to a specialized facility. We expect this will also increase the awareness of these providers concerning the importance of rapid transfer for the most severe conditions and early referral for patients who might not otherwise reach specialty care.

Poor patient compliance and knowledge have been another problem; different patient outreach programs focused on their education were developed with the industry's help. The first was directed at aortic pathologies, and the second was on Peripheral Artery Disease. Upon discharge, it is imperative to have the proper care in the outpatient vascular clinics to ensure continuity of care. This is being achieved by gathering all the information about pathologies, comorbidities, and surgery performed since the first contact with the patient in our database to have active surveillance of the patient and the center results. A vascular coordinator is responsible to ensure the proper follow up of the patients.

Conclusion

The development of a subspecialty of vascular acute care surgery is an opportunity to restructure the nature of vascular surgical practice in this country, improving patients› care and resultant outcomes while making more efficient use of our limited personnel. Our institution›s VACS center is one the few center focused on vascular pathologies across the USA. Further collaboration with other regional institutions and hospitals is paramount to our mission. Ease of transfer, 24/7 service availability, structured care protocols, and outreach campaigns have been vital points for the center›s early success. The increasing number and complexity of patients requiring emergent vascular intervention in Puerto Rico far exceed the number of vascular surgeons available. The VACS model allows us to achieve our mission of increasing the availability and quality of vascular care.

Key Findings

During the first year of the development of the center we treated 293 patients with acute pathologies such as acute limb ischemia (ALI) and abdominal aortic aneurysm (AAA). Also, we received a total of 134 transfers from 18 hospitals across the island of Puerto Rico, improving the limited availability of vascular surgeons on our island.

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