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The Impact of the COVID-19 Pandemic on the Workload, Case Mix and hospital Resources at a Tertiary Vascular Unit

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Background: : The aim of this study was to examine the COVID-19 pandemic and its associated impact on the provision of vascular services, and the pattern of presentation and practice in a tertiary referral vascular unit.

Methods: : This is a retrospective observational study from a prospectively maintained database comparing two time frames, Period 1(15th March-30th May 2019-**P1**) and Period 2(15th March-30th May 2020-**P2**)All the patients who presented for a vascular review in the 2 timeframes were included. Metrics of service and patient care episodes were collected and compared including, the number of emergency referrals, patient encounters, consultations, emergency admissions and interventions. Impact on key hospital resources such as critical care and imaging facilities during the two time periods were also examined.

Results: : There was an absolute reduction of 44% in the number of patients who required urgent or emergency treatment from P1 to P2 (141 vs 79). We noted a non-significant trend towards an increase in the proportion of patients presenting with Chronic Limb Threatening Ischaemia (CLTI) Rutherford 5&6 (P=0.09) as well as a reduction in the proportion of admissions related to Aortic Aneurysm (P=0.21). There was a significant absolute reduction of 77% in all vascular interventions from P1 to P2 with the greatest reductions noted in Carotid (P=0.02), Deep Venous (P=0.003) and Aortic interventions (P=0.016). The number of lower limb interventions also decreased though there was a significant increase as a relative proportion of all vascular interventions in P2 (P=0.001). There was an absolute reduction in the number of scans performed for vascular pathology; Duplex scans reduced by 86%(P<0.002), CT scans by 68%(P<0.003) and MRIs by 74%(P<0.009).

Conclusion: : We report a decrease in urgent and emergency vascular presentations, admissions and interventions. The reduction in patients presenting with lower limb pathology was not as significant as other vascular conditions, resulting in a significant rise in interventions for CLTI and DFI as a proportion of all vascular interventions. These observations will help guide the provision of vascular services during future pandemics.

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INTRODUCTION

The World Health Organization declared Coronavirus disease (COVID-19) a pandemic on the 11th March 2020. This pandemic immediately put extremely high demand on several healthcare resources such as Critical Care Units (CCUs). This called for plans to postpone elective surgery with a view to reducing the strain on CCUs.[1] Augmentation of staff with colleagues from other CCUs or even non-CCU areas, including vascular surgeons and anaesthetists, was advocated.[2]

In line with the above, on March 13th the American College of Surgeons published online recommendations on the management of elective surgical procedures.[3] The Vascular Society of Great Britain and Ireland (VSGBI) followed suit and issued guidance for clinicians on March 20th 2020, recommending the deferral of elective procedures. The National Health Service(NHS) England issued recommendations in support of urgent intervention in patients with Chronic Limb Threatening Ischaemia (CLTI) and diabetic foot infection (DFI).[4,5]

The combination of repurposing vascular theatre capacity to meet CCU bed demand, redeployment of vascular surgeons and anaesthetists to support CCU teams, [6, 7] and guidelines from different societies to rationalise vascular surgery during the COVID-19 era may have limited the access of patients with various vascular pathologies to hospital assessment and treatment. Furthermore, governmental recommendations on social distancing and self-isolation, together with hospital saturation and reduced access to primary and secondary care services, may have caused a delay in the presentation of patients without COVID-19 who experienced severe cardiovascular events.[8]

We wanted to assess if the COVID-19 pandemic and the subsequent changes to the healthcare services would lead to significant reduction in the number of patients accessing vascular services thereby leading to a reduction in the emergency admissions and procedures.

The aim of this study was therefore to examine the COVID-19 pandemic and the associated impact on the patterns of practice and access to vascular services in a tertiary referral vascular unit.

MATERIALS AND METHODS

Vascular Services in the United Kingdom (UK) are structured using a "hub and spoke" model, with arterial surgery conducted at the hub-site only. The vascular unit forms one of two hubs of the Southeast London Vascular Network with a catchment population of 3.5 million.

Re-Organisation of Vascular Services

In line with published recommendations and benefitting from the experience of colleagues in countries who were ahead of the UK on the pandemic curve at the time, the unit began a rapid restructuring of services at the beginning of March 2020.[4,5] The purpose of the re-structuring was to, redeploy resources, including staff, theatre space, inpatients beds and CCU beds, so that they were available to care for patients with COVID-19. We aimed to maintain a structured pathway for the assessment and management of urgent and emergency referrals whilst reducing unnecessary exposure to hospital by deferring non-urgent procedures and switching to telephonic clinics.

This service restructuring process broadly entailed the following, the full emergency service was maintained at the hub site which included 24 hour, 7 day access to a Vascular Surgeon, Vascular Interventional Radiology service and the emergency department (ED). Elective arterial and venous surgery was deferred. Urgent patients were referred via the on call team, the spoke clinics or primary care using a generic email which was attended 12 hours a day.

Diabetic Foot Clinics (DFCs) were maintained in the hub and spoke hospitals. Our unit Benefits from a one-stop Emergency Vascular Clinic (EVC). This was expanded during the COVID-19 pandemic, offering rapid triage, assessment, management and subsequent follow-up of urgent patients.

Following the partnership between the NHS and private healthcare sector during the COVID-19 pandemic, we were able to benefit from additional operating capacity at a local private hospital.

Data Collection

In order to assess the specific impact of the COVID-19 on the provision of vascular services we used two time frames for comparison, Period 1(from 15th of March 2019 till 30th of May 2019 –P1) and Period 2(from 15th of March 2020 till 30th of May 2020 –P2). Metrics of service and patient care episodes were collected including, but not exclusive to numbers of emergency referrals, number of patient encounters, number of consultations, number of emergency admissions and interventions, type of admission by disease category (CLTI, Aortic Aneurysm, symptomatic carotid), number of imaging procedures performed (Duplex, CT, MRI)

and utilisation of CCU beds. Period 1(Pre-COVID) was subdivided into elective and urgent/emergency procedures where appropriate, whereas in Period 2 just emergency presentations were managed and all other elective activity stopped

A prospectively-collected database including patients' demographics was analysed. All patients were discussed in a dedicated multidisciplinary team (MDT) meeting where the most appropriate intervention was recommended after careful consideration of patients' clinical picture and co-morbidities.

Outcome Measures/Variables

Changes in the workload, case-mix, nature of interventions (open vs endovascular) and type of presentations (elective versus emergency) between the two time periods were analysed. Emergency/Urgent admissions were defined as any patient who required immediate medical or surgical treatment for a vascular condition (Priority 1a, 1b or 2) as per the guidelines issued by the Federation of Surgical Specialty Associations.[9]

Impact on the vascular services, hospital resources such as CCU and imaging facilities during the two time periods were examined. We measured the use of level 3, Intensive care beds (ICU), and level 2, High-dependency Unit beds (HDU) looking at the total number of bed-days as well as the total number of patients in the two time periods.

Statistical Analysis

Absolute numbers/continuous variables were analysed as number per month and expressed as mean (standard deviation) for normally distributed data and median (range) for those without a normal distribution. Data was compared using the independent samples *t* test and Mann–Whitney *U* test for parametric and non-parametric data respectively.

Categorical variables and proportions were compared using contingency tables and analysed using the χ^2 test or Fisher's exact test. For all data relative risk and 95% confidence intervals are stated. Absolute numbers have been used in all cases without standardisation or correction. All analyses were carried out using GraphPad Prism 6 (GraphPad Software, San Diego, California, USA) and SPSS version 22 (IBM, Armonk, New York, USA).

As per NHS Research and Ethics definitions (institutional review board equivalent; available from www.nres.nhs.uk/), this study is not classified as research requiring formal ethics approval and was approved locally as an audit project.

RESULTS

All the elective activity was cancelled in period 2, and the following analysis describes the changes that took place during the COVID era and compares them to the period 1 (Pre-COVID era).

Urgent Outpatient Activity

The total number of outpatient encounters (Main Outpatients, diabetic foot clinics and emergency vascular clinic) decreased significantly from 2084 patients in P1 to 1122 patients in P2 [695(± 47) patients per month vs. 374 (± 29) patients per month, P1 vs. P2, $P = 0.0001$, Unpaired *t*-test, 288 –420 (95 % CI) Tables I and II]. Presentations to the emergency vascular clinic did not significantly decrease (Table I), however there was a significant increase in the proportion of patients presenting with CLTI, Rutherford class 5&6, from 24% in P1 to 34% in P2 ($P = 0.046$), and complications of superficial and deep venous disease (13 – 24%, $P = 0.019$). The number and proportion of patients presenting with deep venous thrombosis (DVT) decreased significantly (11% vs. 2%, $P < 0.0001$) with a non-significant trend towards a reduction in the proportion of patients presenting with symptomatic carotid disease. ($P = 0.08$, Table I).

There was a significant decrease in both the total number of patients [124(±16) vs. 70(±14), $P = 0.012$] and the total number of foot care episodes [524(±24) vs. 199(±49), $P = 0.005$, Table I] in the diabetic foot clinic from P1 to P2. The proportion of patients presenting with diabetic foot infection or ulcers increased from 41 –54% ($P = 0.004$), whereas the proportion of patients seen with non-diabetic foot problems decreased (3 –0%, $P = 0.05$).The number of non-urgent outpatient encounters decreased during the P2 [502(±26) patients per month vs. 249 (±36) patients per month, $P = 0.0027$, Table II]. There was a significant decrease in the proportion of face to face encounters ($P < 0.0001$), with a concomitant increase in the number of telephonic appointments ($P < 0.0001$).

Imaging Activity

There was a significant reduction in the number of scans performed for vascular pathology in our hospital (Table II). There was an absolute reduction in Duplex scans by 86% ($P < 0.002$), vascular CT scans by 68% ($P < 0.003$) and vascular MRIs by

Table I. Pattern and nature of presentations to the vascular services

Presentation	Category *N* (%)	Period 1	Period 2	*P* Value	Relative Risk (95% CI)
Emergency Vascular Clinic Presentation	Total	157	161		
	Mean (SD)	53(±3)	54(±4)	0•20**	(-9.0 – 7.0)
	CLTI Rutherford 5&6	38 (24)	54 (34)	0•046+	0.78 (0.58 – 1.02)
	CLTI Rutherford 4	11 (7)	20 (12)	0•10+	0.67 (0.41 – 1.06)
	Rutherford 3	3 (2)	7 (4)	0•33++	0.60 (0.21 – 1.22)
	DVT LL/UL	16/6 (15)	2/2 (2)	<0•0001++	1.87 (1.46 – 2.22)
	Superficial or Deep Venous Disease	21 (13)	38 (24)	0•019+	0.68 (0.46 – 0.94)
	Symptomatic Carotid	9 (6)	3 (2)	0•08++	1.55 (0.96 – 1.97)
	Aortic Aneurysm	1 (1)	5 (3)	0•21++	0.33 (0.06 – 1.14)
	Post-Operative Complications	38 (24)	19 (12)	0•0039+	1.46 (1.14 – 1.80)
	Misc. (TOS, LL Swelling, Non-PVD)	13 (8)	10 (6)	N/A	
Urgent Admission from EVC		35 (22)	27 (17)	0•10+	1.19(0.90 – 1.50)
Emergency Admissions Presentation	Total	141	79		
	Mean (SD)	47(±5)	26(±6)	0•0015**	(8.4 – 33.52)
	Diabetic Foot Infection	15 (11)	12 (15)	0•39++	0.85(0.56 – 1.14)
	CLTI Rutherford 5&6	43 (30)	33 (42)	0•09+	0.83 (0.65 – 1.02)
	CLTI Rutherford 4	9 (6)	7 (9)	0•59++	0.87 (0.51 – 1.22)
	Acute Limb Ischaemia	10 (7)	9 (11)	0•42++	0.81 (0.48 – 2.07)
	Aortic Aneurysm	15 (11)	4 (5)	0•21++	1.26 (0.89 – 1.53)
	Acute Aortic Syndrome	5 (4)	2 (3)	0•99++	1.12 (0.56 – 1.59)
	Superficial or Deep Venus Disease	13 (9)	3 (4)	0•18++	1.29 (0.89 – 1.57)
	Symptomatic Carotid Disease	5 (4)	1 (1)	0•97++	1.31 (0.68 – 1.60)
	Post-Operative Complications	8 (6)	0 (0)	0•072++	1.59 (1.06 – 3.54)
	Misc.	17 (12)	8 (10)	N/A	
Diabetic Foot Clinic	Total Number of Foot Care Episodes Mean (SD)	1572	599		
		524(±24)	199(±49)	0•005**	(238 – 412)
	Total Number of Patients	374	211		
	Mean (SD)	124(±16)	70(±14)	0•012**	(20 – 88)
Presentation	Diabetic Foot Ulcer/Infection	155 (41)	114 (54)	0•0043+	0.83 (0.73 – 0.94)
	Neuroischaemic Ulcer/Tissue loss	154 (41)	84 (40)	0•69+	1.02 (0.90- – .15)
	Charcot Foot	10 (3)	5 (2)	0•99++	1.04 (0.65 – 1.34)
	Non Diabetic Ulcer/Wound/Pain	12 (3)	0 (0)	0•05++	1.58 (1.20 – 13.5)
	Pathological Fracture	3 (1)	2 (1)	0•99++	0.93 (0.36 – 1.39)
	Follow -Up Care	39 (10)	6 (3)	0•006++	1.40 (1.17 – 1.56)
Urgent Admission (from Foot clinic)		14 (4)	4 (2)	0•32++	1.23 (0.86 – 1.50)

CI, Confidence Interval; CLI , Critical Limb Threatening Ischaemia; DVT , Deep Vein Thrombosis; UL,Upper Limb; LL,Lower Limb; TOS , Thoracic Outlet Syndrome; PVD, Peripheral vascular disease; SD, Standard deviation;Values in brackets – Are relative proportions in %

+X^2,

++Fischer's Exact test,*Mann-Whitney *U* test,

**Unpaired *t*-test.

74% (P <0.009) from P1 to P2. In keeping with the temporary reduction of our screening programme, only 61 surveillance scans were performed during P2 (including aortic, bypass-graft and deep-venous stent) compared to 442 during P1, an absolute reduction of 86%.

Table II. Outpatient and imaging activity

Type of Activity		Period 1	Period 2	*P* Value	Relative Risk (95% CI)
Consultants	Face-to-Face	1274	0	<0•0001++	36 (23 – 57)
Clinic	Telephone	18	628		
Clinical Nurse	Face to Face	171	17	<0•0001+	1.99 (1.7 – 2.3)
Specialist Clinic	Telephone	90	105		
	Total	1553	750		(182 – 324)
	Mean (SD)	502(±26)	249(±36)	0•002**	
Vascular Duplex	Total	1331	188		
Scans	Mean (SD)	443(±27)	62(±19)	0•002**	(328 – 433)
Vascular CT scans	Total	602	192		
	Mean (SD)	201(±37)	64(±18)	0•003**	(71 – 203)
Vascular MRI	Total	345	89		
scans	Mean (SD)	115(±15)	30(±12)	0•002**	(54 – 116)

+X^2,
++Fischer's Exact test,
**Unpaired *t*-test, CI ,Confidence Interval

Emergency Admissions and Vascular Interventions

There was an absolute reduction of 44% across all areas of emergency admissions from 141 patients during P1 to 79 during P2 [47(±5) vs. 26(±6) admissions per month, $P = 0.0015$, Table I]. There was a non-significant trend towards an increase in proportion of patients presenting with CLTI Rutherford 5&6 (30 –42%, $P = 0.09$) and a decrease in proportion of admissions related to Aortic Aneurysm (11 –5%, $P = 0.21$) and superficial or deep venous disease (9 –4% $P = 0.18$).

There was also a 77% absolute reduction in all vascular interventions (Table III), with a total of 166 procedures performed during P2 compared to 715 during P1[$P = 0.001$].When looking at emergency/urgent procedures only, the greatest reductions were seen in the absolute numbers of Carotid interventions (17 in P1 vs. 0 in P2, absolute reduction 100%), Aortic (24 vs. 10, absolute reduction of 58%)and Deep Venous (47 to 20, absolute reduction of 57%). Although the absolute numbers of lower limb interventions also decreased significantly (139 –93, 33% reduction) there was an increase as a relative proportion of all interventions (41% in P1 vs. 57 % in P2, $P = 0.001$, Table III). There was no change in the proportion of major amputations ($P = 0.16$). Endovascular interventions as a proportion of all lower limb interventions (81 –86%, $P = 0.25$) and as a proportion of all aortic interventions (72 –90%, $P = 0.45$) were higher in P2 then P1, but this did not reach statistical significance.

High Dependency and Intensive Care Bed Utilisation

The number of vascular high dependency unit (HDU) bed-days utilisation, as well as total number of patients in these beds fell significantly during P2 (HDU 344 to 68 bed-days, $P = 0.003$, Table IV). The median (range) length of stay per patient in HDU did not increase significantly [$P = 0.41$]. There was an increase in the number of intensive care unit (ICU) bed-days from 264 in P1 to 333 in P2, though this did not reach significance [$P = 0.12$, Table IV]. This was associated with a decrease in the number of patients under our care (non-COVID) in ICU between the two time periods from 66 to 33 ($P = 0.073$), although the length of stay per patient did not change significantly [$P = 0.69$].

DISCUSSION

This study describes in detail the changes to service delivery observed in a tertiary vascular centre during the COVID-19 pandemic. Our results demonstrate a marked shift in the workload, case-mix, nature of presentations, pattern of practice and vascular utilisation of critical hospital resources during the pandemic.

In our institution and in line with national and international guidance to reduce infection risk,[5,6] all elective face-to-face physician-led outpatient consultations were stopped in P2. This was associated with significant increase in telephone consultations in P2. The same pattern was also noted in nurse-led clinics with significant reduction

Table III. Description of vascular interventions during the two time periods

Procedure	Period 1 Elective	Period 1 Urgent/Emergency	Period 2 Urgent/Emergency	*P* Value Urgent/Emergency P1 vs. P2	Relative Risk (95% CI)
Carotid	4	17(5)	0 (0)	0•006++	1.5 (1.23 – 6.42)
Aortic – Open	13	6 (2)	1 (1)	0•27++	1.27 (0.72 – 1.48)
Aortic – Endo	65	16 (5)	9 (6)	0•42++	0.95 (0.65 – 1.19)
Lower Limb - Open	12	26 (8)	13 (8)	0•71+	0.98 (0.74 – 1.19)
Lower Limb Endo	41	113 (33)	80 (49)	0•0005+	0.8 (0.69 – 0.91)
Deep Venous Stent	91	47 (14)	20 (12)	0•39+	1.05 (0.86 – 1.21)
DVT – CDT	N/A	18 (5)	2 (1)	0•02++	1.35 (1.04 – 1.50)
Superficial Venous	138	N/A	N/A	N/A	
Thoracic Outlet Decompression	9	N/A	N/A	N/A	
Major Amputation	N/A	32 (9)	12 (7)	0•16++	1.08 (0.86 – 1.27)
Minor Amputation	N/A	54 (16)	22 (13)	0•23++	1.06 (0.89 – 1.22)
Wound Management	N/A	8 (2)	3 (2)	0•44++	1.08 (0.64 – 1.36)
Misc	N/A	2 (1)	1(0)	N/A	
Total	373	339	163		
mean (SD)	124 (±7.5)	113 (±7)	54 (±5)	0•001**	(45 – 73)

CI, Confidence Interval; UL,Upper limb; LL, Lower limb; DVT, Deep vein thrombosis; CDT , Catheter Directed Thrombolysis.
+X^2 ,
++Fischer's Exact test,
**Unpaired *t*-test,

Table IV. HDU and ITU bed utilisation

Care Level		Period 1 (Bed Days)	Period 2 (Bed Days)	*P* Value	(95% CI)
High Dependency	Total Bed-Days (BD)	344	68		
Unit	Mean (SD) per month	114(±27)	23(±7)	0•003**	(48 – 135)
	Number of Patients	89	20		
	Mean (SD) per month	29(±12)	7(±3)	0•003*	(2 – 42)
	BD/Patient (median -range)	3 (1 – 20)	2 (1 – 12)	0•41*	(-1 – 1)
Intensive Care	Total Bed-Days	264	333		
Unit	Mean (SD) per month	88(±12)	111(±16)	0•12**	(9 – 55)
	Number of Patients	66	33		
	Mean (SD) per month	22 (±5)	11(±6)	0•073**	(-1.5 – 23)
	BD/Patient (median -range)	2(1 – 21)	3(1 – 82)	0•009*	(0 – 3)

CI, Confidence Interva; BD, Bed days; SD, Standard deviation
*Mann-Whitney *U* test,
**Unpaired *t*-test,

in face-to-face appointment and concomitant increase in telephone consultations.[10,11]

Emergency and urgent presentations represent a large proportion of vascular workload under normal circumstances, which is a unique feature of this specialty. In view of this, it was necessary to ensure there was a clear pathway with rapid-access to vascular services during the pandemic. In our institution, this access was maintained through the emergency vascular clinic (EVC), diabetic foot clinic (DFC) and emergency department. Although overall outpatient encounters decreased significantly in P2, we noted that total patient encounters in the EVC did not significantly decrease. In addition, as a proportion of the total emergency workload, there was a significant rise

in patients presenting with CLTI Rutherford 5&6 to the EVC, highlighting the essential role of the EVC and similar "hot clinics" in maintaining access to essential vascular services, particularly those with CLTI. Similarly diabetic foot clinics (DFCs) have been proven essential in providing rapid access to diabetic and non-diabetic foot patients.[12,13] We have shown a significant increase in the proportion of patients presenting with diabetic foot infection or ulceration in P2 although overall numbers decreased.

Overall there was a global reduction (44%) across all areas of vascular emergency admissions as well as a significant decrease (77%) in all emergency interventions. A similar pattern has also been noted in large multicentre studies in patients presenting with cardiovascular[14] and cerebrovascular emergencies.[14,15] This could potentially represent a pattern of delayed presentation, as a result of a number of factors including reduced access to such services, patients' anxiety to attend hospitals[16,17] and efforts to comply with national guidance for patients to stay away from hospitals unless absolutely necessary. These observations are important for public health guidance during future pandemics.

It was important to examine the impact of the vascular services on precious hospital resources such as CCU beds and imaging facilities. Although the number of vascular patients in CCU facilities was not significantly different, these patients tended to stay longer leading to significantly more total CCU bed days in P2. It is not possible to ascertain the reasons behind this observation and whether it reflects a sicker group of patients treated in P2 compared to P1. This observation could be a consequence of the lack of availability of level 2 beds in P2 as they were re-purposed and added to the overall CCU bed pool. This might explain the significant rise in the total CCU bed-days despite overall reduction of vascular activities.[18]

In keeping with national guidance and the findings from COVER trial,[19] our screening programme has been temporarily halted leading to a significant drop in surveillance scans in P2. The same pattern was also noted with the number of other vascular imaging modalities, where vascular CT scans and MRI's significantly dropped in P2, however during the lockdown emergency vascular patients still had imaging done as clinically indicated. Many of these scans, particularly surveillance scans adds to the backlog of elective work which will need to be managed and reduced in the coming months.

A major concern in the healthcare system in the UK is the possibility of a second peak of COVID-19 infection which could put further pressure on NHS resources.[20-22] This calls for clear escalation plans for various aspects of vascular services with defined patient pathways. Our study showed that patients with CLTI and DFI represent the vast majority of the demand on access to the vascular services and vascular interventions. We noted patients with CLTI constituted a significantly larger proportion of emergency admissions and more than half of all vascular procedures performed during P2 were for lower limb revascularisation. We also noted a trend towards more endovascular interventions, although not reaching statistical significance. Our findings were supported by the findings from COVER study which showed a significant shift towards endovascular-first approach during the pandemic.[19] Although it might seem that deferring elective and non-arterial vascular procedures could potentially be implemented with no significant sequelae to patients, this would not be possible or safe to replicate in patients with CLTI or DFI due to the nature of their rapidly progressive disease and its catastrophic consequences. Individual vascular units should establish clear, rapid-access and COVID-protected pathways for this cohort of high-risk patients where they can be assessed and treated in a timely manner. In view of our observations and in line with other published data,[23-25] access to theatre facilities with endovascular capabilities should be secured during any future pandemics to allow for adequate and timely intervention on these patients. In addition, access to Level 2 beds should be maintained during future outbreaks, as this may prevent an increase in Level 3 bed utilisation, thus reducing the strain on this precious resource.

Patients with CLTI and DFI did not decrease at our centre, this reflects that the workload generated by these patients requiring urgent/emergency interventions remained the same. In order to cope with this we increased the capacity of our one stop Emergency Vascular Clinic (EVC), aspects of inpatient care remained the same with multidisciplinary input from various teams such as Vascular surgery, Interventional radiology, Diabetes/ endocrine diseases, Vascular medicine, Podiatry, Infectious diseases and Physiotherapy. We maintained our spoke hospital (South-East Vascular Network) foot clinics with multi-disciplinary support using virtual platforms in order to identify patients who need urgent interventions. We developed Covid-19 protected pathways in our hospital to allow urgent patients to be admitted

and treated with the least risk of getting Covid-19 infection.

The novelty of our service re-design was to provide a fast-track, one-stop service for urgent vascular referrals, by increasing the capacity of the EVC with a full time vascular consultant, specialist nurse, ultrasound angiologist presence and direct access to cross sectional imaging scanners.

This study has limitations which are inherent in retrospective observational studies of this kind. These include the risk of bias and confounding factors, which could not easily be adjusted for. These are also present in other larger multi-centre studies examining the impact of COVID on healthcare provision, but given the relative paucity of evidence currently about this subject, we feel these studies as well as our own are essential in highlighting important changes to service delivery and patterns of presentation during the COVID-19 pandemic, which will be crucial to current and future planning. Our institution is a designated regional centre for high consequence infectious diseases. This may mean that the impact of COVID-19 on vascular services in our hospital was disproportionately high compared with other institutions. Finally we acknowledge that our study may not capture patients managed conservatively/palliated in primary and other secondary care settings, which may also explain why we did not show a significant increase in the number of minor or major amputations over the COVID time period, which is contrary to other studies.[26]

CONCLUSION

The changes to health care provision caused by the COVID-19 pandemic had a significant impact on the delivery of vascular services, There was an overall reduction in vascular activity including outpatient encounters, inpatient procedures, emergency and elective admissions as well as imaging requirements. Patients with CLTI and DFI represented the majority of the workload during the pandemic. We hope that the observations presented here will contribute to clear planning of patients' pathways and capacity as an integral part of any preparation for future pandemics.

PRESENTATION INFORMATION

This study was presented at the Virtual Annual scientific meeting of the Vascular Society of Great Britain and Ireland Scientific meeting 24th-27th Nov. 2020.

AUTHOR CONTRIBUTIONS

M Musajee: Literature search, Study design, Data collection, Data analysis, writing, manuscript review

L. Biasi: Literature search, Data analysis, Figures, Data interpretation, writing, manuscript review

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H Zayed: Study design, Literature search, Data analysis, Data interpretation, writing, manuscript review

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REFERENCES

1. Phua J, Weng L, Ling L, et al. Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations [published correction appears in Lancet Respir Med. 2020 May;8(5):e42]. Lancet Respir Med 2020;8:506–17. doi:10.1016/S2213-2600(20)30161-2.
2. Qiu H, Tong Z, Ma P, et al. China critical care clinical trials group (CCCCTG). intensive care during the coronavirus epidemic. Intensive Care Med 2020;46:576–8 Epub 2020 Feb 20. PMID: 32077996; PMCID: PMC7080064. doi:10.1007/s00134-020-05966-y.
3. American College of Surgeons https://www.facs.org/-/media/files/covid19/recommendations_for_management_of_elective_surgical_procedures.ashx (accessed June 1,2020)
4. Vascular Society of Great Britain and Ireland, COVID-19 virus and vascular surgery. 2020. https://www.vascularsociety.org.uk/professionals/news/113/covid19_virus_and_vascular_surgery (accessed June 1,2020)
5. NHS England, Clinical guide for the management of vascular surgery patients during the Coronavirus

pandemic. 2020. https://www.england.nhs.uk/coronavirus/wpcontent/uploads/sites/52/2020/03/specialty-guidemanagement-of-vascular-surgerypatients-v1-20-march-2020.pdf (accessed June 1,2020)
6. Myles PS, Maswime S. Mitigating the risks of surgery during the COVID-19 pandemic. Lance 2020;396:2–3. doi:10.1016/S0140-6736(20)31256-3.
7. Dunn M, Sheehan M, Hordern J, et al. Your country needs you': the ethics of allocating staff to high-risk clinical roles in the management of patients with COVID-19. J Med Ethics 2020;46:436–40. doi:10.1136/medethics-2020-106284.
8. Scally G, Jacobson B, Abbasi K. The UK's public health response to covid-19. BMJ 2020;369:m1932 Published 2020 May 15. doi:10.1136/bmj.m1932.
9. https://fssa.org.uk/_userfiles/pages/files/covid19/prioritisation_master_240820.pdf (accessed on 11th of November, 2020)
10. Al-Jabir A, Kerwan A, Nicola M, et al. Impact of the Coronavirus (COVID-19) pandemic on surgical practice - Part 2 (surgical prioritisation). Int J Surg 2020;79:233–48. doi:10.1016/j.ijsu.2020.05.002.
11. Kumar Anirudh, Patel Divyang R, Nissen Steven E, et al. Never let a crisis go to waste: implementing virtual innovations during the COVID-19 Pandemic for a better tomorrow in health care. JACC: Case Reports 2020;;2:1376–8 1016/j.jaccas.2020.05.014.
12. Gilbert AW, Billany JCT, Adam R, et al. Rapid implementation of virtual clinics due to COVID-19: report and early evaluation of a quality improvement initiative. BMJ Open Qual 2020;9:e000985. doi:10.1136/bmjoq-2020-000985.
13. Rogers LC, Lavery LA, Joseph WS, et al. All feet on deck-the role of podiatry during the COVID-19 pandemic: preventing hospitalizations in an overburdened healthcare system, reducing amputation and death in people with diabetes [published online ahead of print, 2020 Mar 25]. J Am Podiatr Med Assoc 2020;10 7547/20-051. doi:10.7547/20-051.
14. Fisher D, Teo YY, Nabarro D. Assessing national performance in response to COVID-19 [published online ahead of print, 2020 Jul 15]. Lancet 2020;S0140-6736:31601–9. doi:10.1016/S0140-6736(20)31601-9.
15 Seiffert M, Brunner FJ, Remmel M, et al. Temporal trends in the presentation of cardiovascular and cerebrovascular emergencies during the COVID-19 pandemic in Germany: an analysis of health insurance claims. Clin Res Cardiol. 2020;Dec;109(12):1540–8 1007/s00392-020-01723-9. doi:10.1007/s00392-020-01723-9.
16. Armitage R, Nellums LB. COVID-19 and the consequences of isolating the elderly. Lancet Public Health 2020;5:e256. doi:10.1016/S2468-2667(20)30061-X.
17 Peteet JR. COVID-19 Anxiety [published online ahead of print, 2020 May 15]. J Relig Health 2020;Oct;59(5):2203–4. doi:10.1007/s10943-020-01041-4.
18. Aziz S, Arabi YM, Alhazzani W, et al. Managing ICU surge during the COVID-19 crisis: rapid guidelines. Intensive Care Med 2020;46:1303–25. doi:10.1007/s00134-020-06092-5.
19. The Vascular And Endovascular Research Network Vern Executive Committee The COvid-19 Vascular sERvice (COVER) study: an international vascular and endovascular research network (VERN) Collaborative study assessing the provision, practice, and outcomes of vascular surgery during the COVID-19 Pandemic. Eur J Vasc Endovasc Surg 2020;60:156–7. doi:10.1016/j.ejvs.2020.04.039.
20. Xu S, Li Y. Beware of the second wave of COVID-19. Lancet 2020;395:1321–2. doi:10.1016/S0140-6736(20)30845-X.
21 Ali I. COVID-19: are we ready for the second wave? [published online ahead of print, 2020 May 7]. Disaster Med Public Health Prep 2020;Oct;14(5):1–3. doi:10.1017/dmp.2020.149.
22. Lancet The. COVID-19: the worst may be yet to come. Lancet 2020;396:71. doi:10.1016/S0140-6736(20)31517-8.
23. Shin L, Bowling FL, Armstrong DG, et al. Saving the diabetic foot during the COVID-19 pandemic: a tale of two cities. Diabetes Care 2020;43:1704–9. doi:10.2337/dc20-1176.
24 COVIDSurg Collaborative Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans [published online ahead of print, 2020 May 12]. Br J Surg 2020;Oct;107(11):1440–9. doi:10.1002/bjs.11746.
25. Mouawad NJ, Cuff RF, Hultgren R, et al. The vascular surgery COVID-19 Collaborative (VASCC). J Vasc Surg 2020;72:379–80. doi:10.1016/j.jvs.2020.04.463.
26. Schuivens PME, Buijs M, Boonman-de Winter L, et al. Impact of the COVID-19 lockdown strategy on vascular surgery practice: more major amputations than usual. Ann Vasc Surg 2020;69:74–9 Epub 2020 Aug 4. PMID: 32763458; PMCID: PMC7402273. doi:10.1016/j.avsg.2020.07.025.