



Evaluation Of The Efficacy Of E-Learning In Increasing Theoretical Knowledge And Inducing Behavior Change Amongst Vascular Surgery Trainees

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**EVALUATION OF THE EFFICACY OF E-LEARNING IN INCREASING
THEORETICAL KNOWLEDGE AND INDUCING BEHAVIOR CHANGE AMONGST
VASCULAR SURGERY TRAINEES**

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The Harvard Medical School

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Evaluation Of The Efficacy Of E-Learning In Increasing Theoretical Knowledge And Inducing Behavior Change Amongst Vascular Surgery Trainees

Abstract

Background: In June 2019, new vascular surgery societal guidelines were released for the management of patients with chronic limb-threatening ischemia (CLTI). These guidelines were judged to be essential for clinicians who treat patients with CLTI, and we believed they represented an important and timely teaching opportunity for the vascular surgery community. Therefore, we decided to create an online curriculum, tailored for the needs of vascular surgery trainees, based on evidence-based teaching strategies and meticulous curriculum design, to teach key concepts of CLTI management and to test its efficacy in improving theoretical knowledge and in inducing behavior change amongst vascular surgery trainees in Canada.

Methods: Participants were recruited from the 10 vascular surgery residency programs across Canada. The study uses a quasi-experimental design. Participants were asked to complete a knowledge check before and after interacting with our module. We also used pre- and post-intervention surveys to evaluate learners' satisfaction with the module and impact on behaviour change.

Results: Pre- and post-intervention test scores were compared using paired *t* tests for the 21 study participants. On average, learners scored 33 percentage points higher ($p<0.0005$) after interacting with the module. This increase was significantly greater among senior residents when compared with junior residents (+31 vs +35 percentage points higher), whereas baseline test scores were similar between these two subgroups. Learners' satisfaction with the module was extremely high

and we found that all participants would recommend this module to their peers and would like to engage in similar activities in the future. When evaluating behavior change, we found a trend towards improvement of guidelines compliant prescription patterns after interaction with the module. Indeed, prescriptions of post-procedural antiplatelet therapy were more frequently made according to guidelines recommendations after interaction with the module, although this finding was not statistically significant.

Conclusion: Our study showed that online learning is a powerful tool in surgical residency programs and that residents greatly appreciate this type of educational activity. More research looking at the effect of e-learning on inducing behavior change are needed to prove the efficacy of e-learning in that specific area.

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CHAPTER 1: BACKGROUND

1.1 Background and Significance

In June 2019, the Society for Vascular Surgery, the European Society for Vascular Surgery and the World Federation of Vascular Societies released joint guidelines for the management of patients with chronic limb-threatening ischemia (CLTI).¹ These guidelines introduced a novel integrated approach to aid clinical decision making and significant changes were made in classification systems for wounds and tissue loss as well as for anatomical staging of disease.^{1,2} We believe it is essential for clinicians who treat patients suffering from CLTI to be accustomed with, and to correctly apply these new guidelines as they have proven to lead to better care and prediction of patient outcomes.^{1,3,4} Therefore, we considered it to represent an important and timely teaching opportunity for the vascular surgery community.

Concurrently, work-hour restrictions, patient-care responsibilities, and the necessity to maintain an adequate level of operative experience are commonly cited barriers for surgical trainees to attend traditional didactic sessions.^{5,6} For faculty, time constraints and clinical responsibilities also represent constant challenges for continuing medical education.⁷ To overcome these problems and to maintain a thriving learning environment, online curriculums have recently grown in popularity and have shown to be very effective in surgical residency programs.^{7,8} A few studies have also shown their efficacy in vascular surgery training.^{9,10} A recent needs assessment study for e-learning resources in vascular surgery highlighted that vascular surgeons and trainees both favor the development of a variety of online modules with the most requests towards illustrations and videos of surgical techniques, as well as peer-reviewed multiple-choice questions (MCQ).¹¹ More recently, with the COVID-19 pandemic, an international survey (The EL-COVID survey) was

conducted with 856 vascular surgeons from 84 different countries and revealed that the vascular surgery community is adapting well to the shift towards online learning and that these resources are greatly appreciated.¹² The authors also hope that the pandemic will result in an increase in appreciation and more development of vascular surgery online curriculums.^{12,13} The EL-COVID survey also found that asynchronous activities are preferred because of their flexibility and possibility to adjust to the vascular surgeons' busy schedules.¹²

Indeed, the 24/7 accessibility of asynchronous online modules is a feature that resonates well with the demanding schedules of vascular surgeons and trainees, and which makes e-learning a powerful tool for surgical education. It is also a way for professors in smaller programs (with some vascular surgery programs in Canada counting as few as three residents) to disseminate the lessons they spent time and energy creating to a wider audience. It even allows residents and vascular surgeons from around the globe to receive education from content experts without having to worry about the time and the cost associated with traveling.¹⁴

However, a common critique of the available research looking at the efficacy of e-learning in health professions is that it often concentrates efforts on demonstrating differences in test scores or appreciation of the learning experience between users and non-users.^{7,15} Indeed, few studies explore the impact of e-learning on higher levels of learning evaluation such as behavior change among practitioners.^{7,15}

1.2 Conceptual Framework

Online curriculums are well in-line with adult learning theory as it was initially described by Lindeman in 1926.¹⁶ Two of the “key assumptions” for adult learners were that “*adults have a deep need to be self-directing*” and that adult learning has to be “*life-centered*”.¹⁷ As it was further

explored by Knowles, self-directed learning is described as "*a process in which individuals take the initiative [...] in diagnosing their learning needs, formulating goals, identifying human and material resources, and evaluating learning outcomes*".¹⁸ Accordingly, when creating this asynchronous online module, we aimed to offer vascular surgeons and trainees a simple way to access the resources they need to accomplish their personal learning goals and to test their knowledge at their own pace. By choosing the subject of CLTI, one of the most common reasons for consultation in vascular surgery, we wished to make this experience more “*life-centered*” and help learners relate to their previous personal experiences. The module also uses common educational strategies like spacing and interleaving, retrieval practice and testing effect to make the experience as profitable as possible for the learners.¹⁹

This project is also based on Mayer’s cognitive theory of multimedia learning.²⁰ In this theory, the assumption is that the human brain has distinctive channels for processing visual and auditory inputs. Since each channel can only process a certain number of elements at any one time (limited capacity principle) the use of multiple media can improve the processing of new information and therefore help integrate knowledge in long-term memory.²⁰

1.3 Specific Aim

The purpose of this study was to create an online curriculum, tailored for the needs of vascular surgery trainees, to teach key concepts of CLTI management and to test its efficacy in improving theoretical knowledge and in helping to put into practice evidence-based approaches to treatment. Even though this module focuses on a topic related to vascular surgery, we believe it can serve as a proof of concept for how e-learning can similarly be used to educate health professionals in general.

1.4 Objectives

The objectives for this study were to test the outcomes of our online curriculum on three different levels of Kirkpatrick's Four Level Model of Learning Evaluation²¹:

Figure 1. The Kirkpatrick Model – Four Level Model of Learning Evaluation

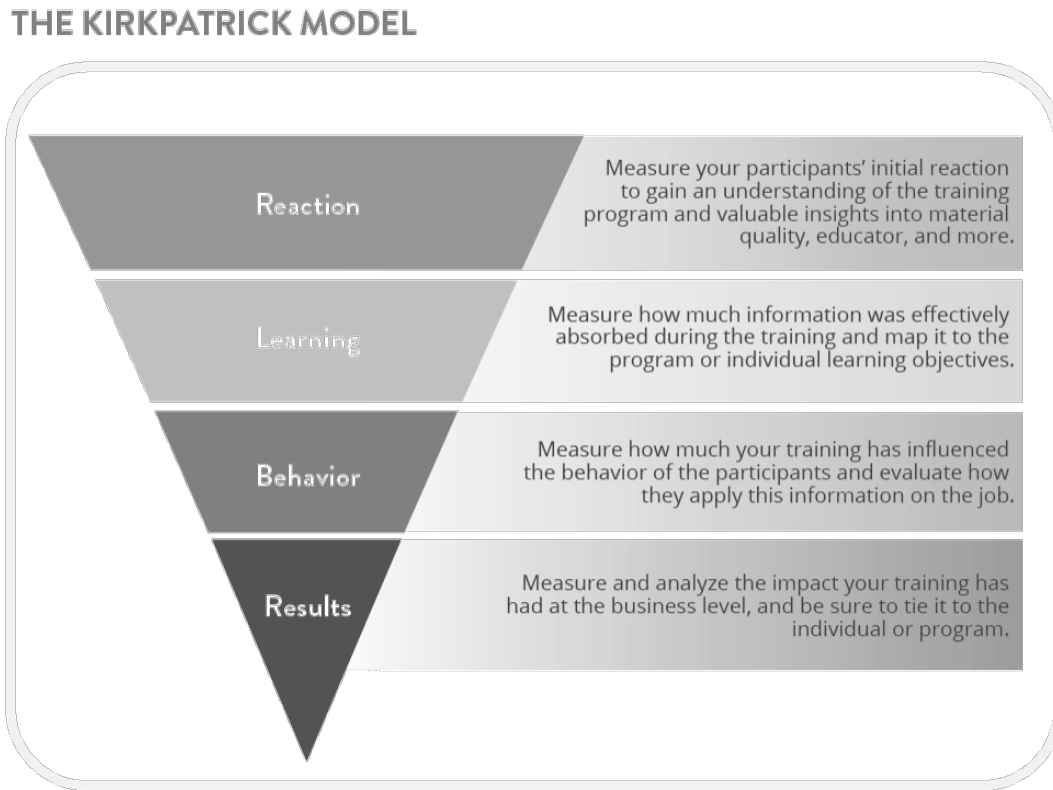


Image from <https://learning.linkedin.com/blog/learning-thought-leadership/the-best-way-to-use-the-kirkpatrick-model--the-most-common-way-t>

Reaction - Objective 1: Evaluate the level of satisfaction of vascular surgery residents with the use of our online curriculum.

Learning - Objective 2: Evaluate the amount of CLTI-related knowledge gained by vascular surgery residents after using our online curriculum.

Behavior - Objective 3: Evaluate if the use of our online curriculum influences how vascular surgery residents apply the guidelines and approach the management of patients with CLTI.

CHAPTER 2: METHODS

2.1 Research Questions and Outcomes

The variables and outcomes in this study were evaluated for the whole study population and were also stratified to look at results for junior residents versus senior residents and clinical fellows.

- **Question 1:** What are the perceptions of the participants on the use of an online module to teach new guidelines for management of CLTI?

Outcome: Overall appreciation of the experience measured through a survey after completion of the curriculum. More specifically, we evaluated satisfaction, engagement, time spent on the module, and ease of use.

- **Question 2:** Does the implementation of an online teaching module on CLTI guidelines increase theoretical knowledge?

Outcome: Pre- vs Post-intervention test results (multiple-choice and short answer questions).

- **Question 3:** Does the implementation of an online teaching module on the new CLTI guidelines improve the way vascular surgery trainees apply the guidelines in their daily practice?

Outcome: Behavior change was explored through a survey administered two months post-intervention. Participants were asked to self-report their use of new classification systems and we also compared prescription patterns for antiplatelet medication pre- versus post-intervention.

2.2 Research Approach

Since the guidelines were published in the Journal of Vascular Surgery in June 2019, our assumption was that practicing vascular surgeons and residents were aware of the existence of these new guidelines and that, one year after publication, they should have read or at least have heard about most of the content included in the guidelines through lectures or meetings. Our study follows a **quasi-experimental approach with pre/post-test design** and can be broken down into four steps as follows: *(see Appendix A for a detailed timeline of the project)*

STEP 1

A pre-intervention (baseline) test and survey were designed to be administered in the Fall of 2020 (before students could engage with the online module) to look at pre-existing knowledge and behavior with traditional implementation of guidelines in the vascular surgery community. (See **Appendix B** for pre-intervention test and survey)



STEP 2

After completing the pre-intervention test and survey, study participants had two weeks to access the online module which consists of a variety of teaching strategies like videos, texts, illustrations, quizzes, and interactive cases summarizing the content of the guidelines and other relevant literature. (See link to module: https://rise.articulate.com/share/IDbVsMdvYoXd8g_YLPRcx1Ckcn0QfAHN)



STEP 3

After interacting with the module, study participants were asked to complete a post-intervention test and a satisfaction survey. (See **Appendix C** for post-intervention test and satisfaction survey)



STEP 4

Two months after the post-intervention test, study subjects were asked to answer follow-up questions to evaluate if their approach to CLTI (or behavior) has changed. The answers to these follow-up questions were compared to the pre-intervention survey answers. (See **Appendix D** for follow-up survey)

2.3 Conditions

We analyzed the data in two different groups according to residency level since we believed the benefits might be different amongst these groups. The groups were separated as such:

- Junior residents (PGY 1-2-3)
- Senior residents (PGY 4-5 and Clinical Fellows)

2.4 Ethics Approval

The project was approved by the Harvard Faculty of Medicine Institutional Review Board (IRB) on July 22, 2020 (Protocol #IRB20-1299). Please see *Appendix E* for proof of ethics approval.

2.5 Curriculum Creation

From January 2020 to May 2020, the online module was created using the Articulate Rise 360 E-learning authoring tool (Articulate Global, Inc, New York, NY) by the principal investigator (JB). The content of the Global vascular guidelines on the management of chronic limb-threatening ischemia¹ was reviewed, summarized and curated into a list of specific objectives to cover in the module. We then developed the curriculum using a backwards design approach as described in Kern's Six-Step Approach to Curriculum Development in Medical Education.²² The draft of the online module was then sent for review/expert consultation which was then followed by pilot testing, as is recommended in the AMEE guide for developing questionnaires for educational research.²³ Written feedback was obtained via the Review 360 feature of the Articulate platform. The module was first reviewed by an expert in online module development for medical education (thesis mentor Dr. Krisztina Fischer) and modifications were made to the flow of the module. Indeed, interactive features such as case-based learning were added to promote student engagement and some sections with a large amount of written text were modified to include more

audio commentaries or short videos to explain key concepts. The module and pre- and post-test were then sent for review by a content expert (vascular surgeon and thesis committee member Dr. Pascal Rhéaume). Modifications were made to the content of some sections of the module. For example, some text was adjusted, and some questions were reformulated to increase the generalizability of the material for differences in practice across different centers. Also, figures were added in some sections to replace or accompany some of the text.

Surveys and knowledge checks were created and distributed through the Qualtrics Survey tool (Qualtrics, Provo, UT). The module was distributed via the Rise.com Learning Management System (LMS).

2.6 Pilot Testing

In July and August 2020, we selected a convenience sample of four residents of different levels of training (one PGY2, two PGY5s, and one clinical fellow), from four different universities, to conduct pilot testing of the module and to test the knowledge checks and surveys to be used in the study. We also collected feedback on the quality of the content and ease of use for the module and learning management system. In addition, the pilot testing served as a way for the research team to familiarize ourselves with the learning management system and the Qualtrics platform, to ensure a smooth execution during the enrollment and study period.

Following this pilot testing we needed to modify some of the interactive features that were not loading properly to the LMS platform in one of the sections of the module. For example, links to angiography images were not loading properly and were replaced by virtual flashcards which were easier for students to click through and analyze.

It was also brought to our attention that some information was missing to answer some of the questions in the knowledge checks, therefore these questions were modified accordingly before the start of the study. More specifically, there was a question where students were asked to calculate the Wifl classification, but the information to grade the “Ischemia” part of the Wifl classification was not provided in the question. In another question, students were asked to identify the GLASS stage of a lesion with angiographic images. Students mentioned that it was difficult to calculate the length of the occlusion, so this information was added to the question.

The pilot testing was also useful to determine the time needed to complete the module for the students. In general, learners needed 3-4 hours to complete the surveys/tests/module, which allowed us to confirm that it was the perfect length to be included in the curriculums of residency programs as one of their academic half-days.

Finally, it was also suggested by one of the students to add a link to the module at the end of the pre-intervention test, and a link to the post-intervention test at the end of the module to facilitate navigation within the module and so that students would not have to go back and forth to the module and the recruitment email to find links for the activity. This was therefore added before the start of the study period.

2.7 Recruitment and Study Sample

In the first week of September 2020, a national meeting was held (virtually) for vascular surgery residency program directors across Canada during the Annual Meeting of the Canadian Society for Vascular Surgery. We used this opportunity to present our research project, to promote our module, and to invite residency program directors to organize their academic calendar for this activity to be included in one of their upcoming academic half-days during the Fall 2020 session.

Of the ten Canadian vascular surgery programs, five were able to secure protected time for their trainees to participate in the study during the Fall 2020 session, for a total of 34 residents to be potentially recruited in the study. Participation in this research project was voluntary (See Appendix B) and participants were made aware that it would not impact their academic standing in any way if they chose not to participate, or if they chose to only access the module without completing the associated tests and surveys to participate in the study. Program directors were not told which, or how many, of their residents decided to participate, and they were only given aggregate scores for the pre- and post-intervention tests. Students' email addresses were obtained from their respective residency program directors. Recruitment emails were sent by the principal investigator (JB) one week before the academic half-day chosen by their residency program director to provide the links to the LMS where the activity was hosted.

2.8 Data Collection

Data collection was done using:

- Test scores (pre- vs post-intervention)
- Curriculum satisfaction survey results
- Pre-intervention vs. Follow-up survey results to assess behavior change

2.9 Data Analysis

Our hypothesis was that test scores and compliance to guidelines in everyday practice would improve after the intervention. Our primary outcome analysis was to compare mean pre- vs post-intervention test scores using paired *t* tests and to report results by showing differences in means with *p*-values and 95%-confidence intervals.²⁴ We also compared and stratified results for junior residents vs. senior residents/clinical fellows to determine if one of these groups responds better

to teaching through online curriculums. This will also be presented by showing differences in means with *p*-values and 95%-confidence intervals.²⁴

Statistical analysis was done by the principal investigator (JB) using StataIC version 16.1.872 (StataCorp, College Station, TX).

Level of satisfaction with the module was explored through a series of multiple-choice questions to evaluate ease of use, time needed to engage with the content, relevance of different teaching modalities used in the module, and clarity of course material. We also used Net Promoter Scores (NPS) to rate the willingness of learners to recommend this type of activity to their peers (*see Figure 2 to see how NPS was calculated*). At the end of the survey, we also provided a text box for comments and suggestions in order to collect qualitative data on satisfaction or suggestions for future iterations of the module.

Figure 2. Net Promoter Score

How likely would you be to recommend this module to a colleague?

Not at all likely Extremely likely

0 1 2 3 4 5 6 7 8 9 10

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

DETRACTORS							PASSIVES		PROMOTERS	
0	1	2	3	4	5	6	7	8	9	10

NPS Score = % of Promoters - % of Detractors

Image from [https://support.zendesk.com/hc/en-us/articles/203981113-Analyzing-your-Net-Promoter-Score-NPS-survey-results#:~:text=Click%20the%20Reporting%20icon%20\(%20\)%20in,for%20your%20latest%20NPS%20survey.&text=Under%20Your%20score%2C%20you%20can,well%20as%20the%20response%20rate.](https://support.zendesk.com/hc/en-us/articles/203981113-Analyzing-your-Net-Promoter-Score-NPS-survey-results#:~:text=Click%20the%20Reporting%20icon%20(%20)%20in,for%20your%20latest%20NPS%20survey.&text=Under%20Your%20score%2C%20you%20can,well%20as%20the%20response%20rate.)

For the third objective of this study (assessment of behavior change), responses to survey items were compared from pre- and post-intervention answers to assess behavior change. Domains to be explored include everyday use of the new classification systems introduced in the guidelines and compliance to recommendations for antiplatelet medication prescription following revascularization procedures. Answers to these questions were transformed into binary data and hypothesis testing was done using proportion testing.

CHAPTER 3: RESULTS

3.1 Study Population

Of the 34 potential study participants from the five vascular surgery residency programs who participated in the study, 21 students completed the pre- and post-intervention test after spending on average 3-4 hours engaging with the module. This amounts to a participation rate of 62%.

3.2 Pre- and Post-Intervention Test Scores

The knowledge check which was used to evaluate knowledge of the guidelines was created based on the objectives of the module and contained 27 questions for a total of 40 points. The same knowledge check was administered before and after the module in order to be able to adequately measure knowledge gain. Study participants did not receive the answers to the test for the duration of the study period but received their pre- and post-intervention test scores by e-mail after they completed the follow-up survey.

Table 1. Descriptive statistics for pre- and post-intervention test scores for study population

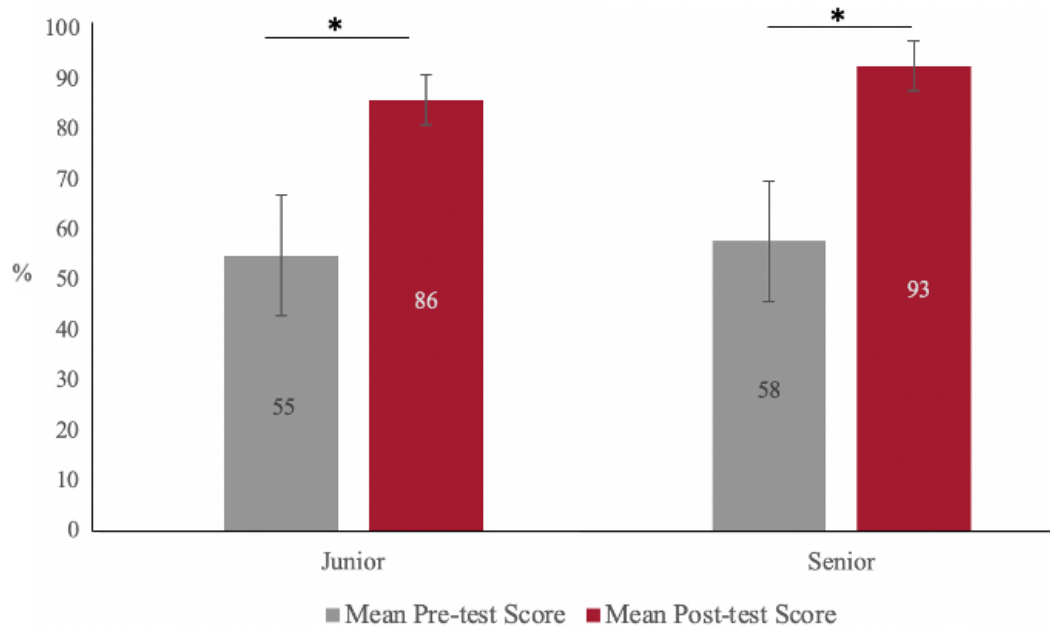
	PRE-test mean score	POST-test mean score	Pre- vs Post- test difference	<i>p-value</i>	95% CI
All residents (n=21)					
Test score	23/40	36/40	+13 points	<0.0005	[10.54, 16.02]
Percentage	57%	90%	+33 %points	<0.0005	[26.36, 40.07]
Junior residents (n=10)					
Test score	22/40	34/40	+12 points	0.0006	[6.85, 17.75]
Percentage	55%	86%	+31 %points	0.0006	[17.13, 44.37]
Senior residents (n=11)					
Test score	23/40	37/40	+14 points	<0.0005	[11.29, 17.08]
Percentage	58%	93%	+35 %points	<0.0005	[28.22, 42.69]

The pre-test mean score for the 21 study participants was 23/40 (57%) and the post-test mean score was 36/40 (90%), meaning that students had an average increase of +13 points (or +33 percentage points) after interacting with the module. This increase in test scores was statistically significant with a p -value <0.0005 .

The pre-test mean score for the 10 junior residents was 22/40 (55%), which was not statistically significantly different (p -value of 0.828) from the pre-test mean score for the 11 senior residents, which was 23/40 (58%). This leads us to believe that knowledge of the guidelines before interacting with the module was similar between the two groups and confirms that our intervention was timely and important because the module addresses a knowledge gap in this population of trainees.

The post-test mean score for the junior residents was 34/40 (86%), for an increase of +12 points (or +31 percentage points), whereas the post-test mean score for the senior residents was 37/40 (93%), for an increase of +14 points (or +35 percentage points). This difference in increase of test scores between the two groups was statistically significant with senior residents scoring on average 7.75 percentage points higher on the post-intervention test ($p=0.0445$, 95% CI [0.24,15.26]) (*see Figure 3 below*).

Figure 3. Difference in Pre- vs Post-Test Scores for Junior (n=10) vs Senior Residents (n=11)
(in Percentage, * = statistically significant difference - p -value <0.05)



3.3 Satisfaction Survey Results

The satisfaction survey was completed by 16 of the 21 study participants for a response rate of 76%.

3.31 Time spent on the online module

The majority of trainees (12/16) reported spending 3-4 hours exploring the content of the module. Three trainees reported spending 5-6 hours engaging with the online module, and only one trainee reported spending 7 or more hours on the online module.

3.32 Ease of use

When asked to rate the ease of use of the module on a 5-point Likert scale from “Very difficult” to “Very easy”, the vast majority of trainees (13/16) rated it as “Very easy”. Two

trainees said it was “Somewhat easy” and one trainee said it was “Neither easy, nor difficult”.

3.33 Usefulness

On a 5-point Likert scale ranging from “Not at all useful” to “Extremely useful”, 14 out of the 16 respondents said the module was “Extremely useful” for their learning and the remainder said it was “Very useful”.

Study participants were also asked to rate the usefulness of the different media and teaching strategies used in the module for their learning process. Specifically, they were asked to rate the written text, the videos, the audio commentaries, the embedded quizzes, the clinical cases, and the pre- and post-intervention tests using the following matrix table:

Figure 4. Matrix table used in the satisfaction survey

Please rate the usefulness of each of these components of the module in your learning process:

	Not very useful	Slightly useful	Moderately useful	Very useful	Extremely useful
Written text	☐	☐	☐	☐	☐
Videos	☐	☐	☐	☐	☐
Audio commentaries	☐	☐	☐	☐	☐
Embedded quizzes	☐	☐	☐	☐	☐
Clinical cases	☐	☐	☐	☐	☐
Pre and Post-test	☐	☐	☐	☐	☐

Following analysis of the results of this matrix table in our study population, we learned that the most appreciated sections of the module were, in order of appreciation, the embedded quizzes, the clinical cases and the pre- and post-intervention tests, which were rated as “Extremely useful” by 100%, 94%, and 88% of study participants, respectively. This is not surprising when we refer to the results of the needs analysis study for e-learning

in vascular surgery previously referenced¹¹, which showed that peer-reviewed questions were amongst the most requested items to be included in e-learning activities. With regards to the different media being used in the module, written text was judged to be the most useful, followed by videos, whereas audio commentaries were rated last.

3.34 Overall satisfaction

When trainees were asked to rate their overall satisfaction with the module on a 5-point Likert scale from “Very dissatisfied” to “Very satisfied”, all respondents (16/16) answered that they were “Very satisfied”. They were also unanimous in responding that they were “Very likely” to engage in similar activities in the future, when asked to rate on a 5-point Likert scale from “Very unlikely” to “Very likely”.

3.35 Net Promoter Score (NPS)

We used the NPS to evaluate the willingness of study participants to recommend our module to their peers. Please see *Figure 5* below from the satisfaction survey.

Figure 5. Net Promoter Score used in the online module satisfaction survey

How likely would you be to recommend this module to a colleague?



Survey results revealed that 15 of the 16 study participants gave the module a score of 10 and 1 trainee gave it a score of 9. These results translate into a Net Promoter Score of 100, meaning that all survey respondents are considered to be “Promoters” of the module.

3.36 Comments and suggestions

A total of six study participants wrote comments in the free-text box at the end of the satisfaction survey. The qualitative feedback received via this free-text box was unanimously very positive as you can see in *Table 2* below.

Of note, one of the trainees (ID OT05) described in detail what they thought was particularly helpful in the module by referring to the various teaching strategies we used: *“This module was extremely helpful to better understand and familiarize myself with a complex and heavy guideline. The diversity of teaching methods (audio, video, text) keeps the learner interested. The quizzes throughout the module were good to help with retention. I also enjoyed a lot the exercises to stage wounds/disease with the WfI and GLASS classifications, which allowed to apply the concepts right away. The relevant information about the main trials was present, with links if we wanted more information. A great module, I will refer back to it [...].”*

Table 2. Qualitative feedback from the satisfaction survey

Participant ID	Comments and suggestions
L5	<i>Excellent module very useful! Thank you!</i>
OT02	<i>Fantastic module</i>
OT05	<i>This module was extremely helpful to better understand and familiarize myself with a complex and heavy guideline. The diversity of teaching methods (audio, video, text) keeps the learner interested. The quizzes throughout the module were good to help with retention. I also enjoyed a lot the exercises to stage wounds/disease with the WfI and GLASS classifications, which allowed to apply the concepts right away. The</i>

	<i>relevant information about the main trials was present, with links if we wanted more information. A great module, I will refer back to it in the next few weeks, thank you!</i>
Q2	<i>More modules like this one should be incorporated in the vascular surgery program curriculum</i>
L6	<i>Excellent module. In the GLASS section, all the tables were in the video. It would be helpful to have them in the text as well.</i>
MT01	<i>Very well-designed module. Excellent content, interactive with clinical cases and quizzes</i>

It was also interesting that one of the trainees (ID L6) suggested that the tables introduced in some of the videos should also be available in the text. This way, learners can refer back to the information in the table without having to listen to the whole video again.

3.4 Behavior Change Data:

Behavior change was evaluated by comparing answers from the pre-intervention survey to answers from the follow-up survey, which was sent to study participants 2 months after the activity. The pre-intervention survey was completed by the 21 study participants whereas the follow-up survey evaluating behavior change was completed by 15 of the 21 study participants, for a response rate of 71%.

3.41 Most frequently used classification system for peripheral artery disease

In the pre-intervention survey, we asked study participants to name the classification system they use the most frequently to stage peripheral artery disease. The same question was asked in the follow-up survey to evaluate if interaction with the module changed the way they approach, or stage, peripheral artery disease.

The classification system used the most frequently did not change pre- vs. post-intervention for any of the study participants. The most popular classification system used by vascular surgery residents remained the Rutherford classification system (8/15), followed by the Fontaine classification system (5/15), and the WIfI classification system (2/15).

3.42 Use of the WIfI classification

The global vascular guidelines on the management of CLTI strongly recommend the use of a *“lower extremity threatened limb classification staging system (eg, SVS’s WIfI classification system) that grades wound extent, degree of ischemia, and severity of infection to guide clinical management in all patients with suspected CLTI”*¹. Therefore, we wanted to evaluate if interaction with our module increased the use of this new classification system in daily practice amongst vascular surgery trainees.

According to the results of the pre-intervention survey, the majority of the study participants (11/21 or 52%) had never used the WIfI classification in practice. In the post-intervention survey, 7/15 participants still had not used the classification system in their clinical work, but 8/15 (53%) participants reported using the WIfI classification system at least “sometimes” since interacting with the module (over the last 2 months). Furthermore, 1 study participant changed his/her behavior from “never” using the WIfI classification to using it “most of the time” and 1 study participant changed from using it “sometimes” to “always” using this new classification system.

Even though the majority of the study participants (52%) did not use the WIfI classification before the activity whereas the majority (53%) used it at least sometimes after the activity,

we found no statistically significant difference for the use of the Wifi classification between the pre-intervention and the post-intervention survey ($p=0.7353$).

3.43 Use of the GLASS classification

The Global vascular guidelines on the management of CLTI also introduce the Global Limb Anatomic Staging System (GLASS) and recommend its use in practice as a “Good Practice Statement”.

The results of the pre-intervention survey showed that none of the 21 study participants had ever used GLASS in their practice and 5/21 did not know what the GLASS was before engaging with the module. After completing the module, 8/15 respondents reported having used the GLASS to stage PAD or to predict the technical complexity of endovascular procedures after interacting with the module. This change in behavior was statistically significant ($p=0.0001$).

3.44 Post-procedural antiplatelet medication prescription patterns

Study participants were asked to write antiplatelet orders for fictional patients after different types of revascularizations (endovascular treatment, venous bypass, and prosthetic bypass). We compared the orders to the guidelines’ recommendations to judge if the orders were compliant to current guidelines or not. This data was transformed into binary data (“compliant” or “non-compliant”) for statistical analysis.

Before the intervention, the orders were made according to the guideline recommendations in 29 of the 63 orders (46% correct orders).

After the intervention, the orders were made according to the guideline recommendations in 22 of the 39 orders (56% correct orders).

Even though there was a greater percentage of orders made according to the guideline recommendations after the educational activity (56% vs 46%), this difference was not statistically significant ($p=0.3083$).

CHAPTER 4: DISCUSSION

4.1 Gain in Knowledge

The results of this study show that, in our study population of vascular surgery trainees, general knowledge of the Global Vascular Guidelines on the Management of CLTI was suboptimal before the proposed learning activity. Therefore, we confirmed our belief that the content of this learning activity was relevant and timely for this population of learners. Our results also demonstrate that the learning activity we created, which consisted of a combination of online module and self-evaluation of knowledge via pre- and post-intervention tests, was able to induce a significant gain in knowledge amongst study participants. Indeed, comparison of pre- and post-intervention test scores showed that the learning objectives were met, and that information was absorbed as we intended. We believe that this knowledge gain can potentially translate in better evidence-based care for patients with CLTI. This suggests that online learning can be very effective at translating new information such as societal guidelines and that our generation of learners responds well to this type of learning activity. The example used in this study with the Global Vascular Guidelines on the Management of CLTI could easily be replicated with other guidelines in the future and we would expect similar results, as long as curriculum design is done in a similar fashion as the one described in our study.

Another interesting finding was the comparison of knowledge gain amongst junior vs. senior residents and clinical fellows. As previously reported in the results section, this difference in increase of test scores between the two groups was statistically significant with senior residents scoring on average 7.75 percentage points higher on the post-intervention test ($p=0.0445$, 95% CI [0.24,15.26]).

This finding is of particular interest since both groups started with similar baseline knowledge of the guidelines according to the pre-intervention test. These results are in keeping with adult learning theory, which states that experience serves as a basis for future learning activities and that it helps learners encode and recall information better.¹⁰ In our study, senior residents, who represent learners with more experience managing CLTI, were able to gain more knowledge from the online learning activity, perhaps because they could link new information to previous experiences and therefore ease the processing of this new information.

4.2 Learners Satisfaction

We were also able to show that the intervention was very well received by Canadian vascular surgery residents and that all the participants would recommend this module to their peers and would like to engage in similar activities in the near future. This reinforces our hypothesis that e-learning is a powerful teaching tool in surgical residency programs. We believe it reaches such high satisfaction levels because of its flexibility, and because it allows learners to take their learning into their own hands, at their own pace. However, in order to reproduce such results, we strongly believe that online learning activities should be rooted in meticulous curriculum and instructional design, from the needs assessment stage to the delivery stage, and should include a variety of media and evidence-based teaching strategies.^{19,20,22,24} We also want to highlight the importance of allowing time for expert review and pilot testing of the content before delivery of the final product.²³

When designing this learning activity, we used adult learning theory¹⁶ and multimedia principles for learning experiences²⁰ as a conceptual framework to guide the creation of the curriculum. We knew that our learners would need to be able to *self-direct* their learning and that they wanted to be able to *evaluate their learning outcomes*.¹⁶⁻¹⁸ The results of the satisfaction survey allowed us

to confirm that this goal was achieved and that learners strongly appreciated the fact that we included self-evaluation sections such as the embedded quizzes, the interactive cases and the pre- and post-intervention knowledge checks. Furthermore, this was also an example of how the use of needs assessment studies can help design stronger curriculums. Indeed, as mentioned in the background section of this manuscript (1.1), a recent needs analysis for e-learning resources in vascular surgery showed us that learners wanted to have access to more peer-reviewed multiple-choice questions.¹¹ Accordingly, when we followed these recommendations, high levels of satisfaction were achieved.

4.3 Inducing Behavior Change

We also aimed to evaluate behavior change in our population of trainees. When looking at the use of a new classification system (Wifl) for chronic limb-threatening ischemia, we were not able to induce a significant change in behavior. We believe this might be due, in part, to the lack of use of this new classification system in practice by the trainees' supervisors, which in turn does not encourage them to change by fear of not being understood if they do not use the same system. Other classification systems such as Rutherford and Fontaine have been used for decades and changing for the newer Wifl classification might still take a few years, even though it is now recommended in vascular surgery societal guidelines.

Furthermore, although antiplatelet prescriptions were more frequently made according to guidelines recommendations after the activity, we were not able to show a statistically significant difference in prescription patterns for post-procedural antiplatelet therapy. Again, this might be because trainees tend to replicate their supervisor's orders as they are being taught during residency, and this might not always reflect exactly the current guidelines recommendations. Also, the guidelines were written before the results of two important randomized control trials were

made available, VOYAGER-PAD²⁵ and COMPASS²⁶, which have since changed the practice of many vascular surgeons with regards to antiplatelet therapy with an increasing use of Rivaroxaban 2.5mg BID rather than the classic dual antiplatelet therapy as recommended in the 2019 Global Vascular Guidelines.¹

The only behavior change that was statistically significant in our study was for the use of the Global Limb Anatomic Staging System (GLASS). Indeed, before the study period, none of the 21 trainees used the GLASS, whereas 8 out of the 15 trainees who completed the follow-up survey said they used the GLASS after interacting with the module. As opposed to the Wifl classification which aims to replace well-established and appreciated classifications such as the Fontaine and Rutherford classifications, the GLASS was introduced to replace another staging system (TASC) that has long been criticized in the vascular community.²⁷ We believe this might explain why it was easier to induce behavior change in that specific domain.

It is possible that online learning might be less effective at inducing behavior change than in-person educational activities because it is usually shorter in duration and less repetitive than supervisor-trainee interaction on a day-to-day basis. Another potential cause might be that, in the time it takes to create an online learning activity, new information or new literature might be published, and results from a recent RCT might affect a clinician's practice more than a summary of guidelines.

It is well-known in medical education and e-learning research that demonstrating significant changes in the first two levels of Kirkpatrick's pyramid of learning evaluation (i.e. Reaction and Learning) is somewhat easier than inducing behavior change.^{15,28} We believe it is still important to evaluate learning on this higher level and encourage further research in this area.

4.4 Dissemination of the Module

Another outcome of this study was to demonstrate how online curriculums can be used to reach a wider audience than traditional didactic sessions. Within the span of four months (Fall 2020 academic session), we were able to deliver this learning activity to more than 20 residents from five different vascular surgery residency programs across Canada, whereas the typical Canadian vascular surgery residency program would usually count approximately five residents. This learning activity is also still available for other programs who may wish to participate after seeing the results of our study. The content of this module can also easily be accessed later and serve as preparatory work for vascular surgery board examinations, and it could also serve as continuing medical education for vascular surgeons. With some adjustments, it could also be delivered as an educational activity for other healthcare providers who take part in the care of CLTI patients such as cardiologists, interventional radiologists and vascular medicine specialists. The fact that online modules are so easy to access and to share with other programs is definitely an advantage that in-person didactic teaching will never be able to compete with.

4.5 Limitations

This study has several limitations. First, the sample size of 21 vascular surgery residents is relatively small when comparing to other medical specialties but remains a respectable size considering the small number of vascular surgery residents in Canada. We were able to achieve a participation rate of 62% (21/34) among the five programs who accepted to participate in the study, but we believe that we could have reached a higher participation rate if the allocated time given to the learners in some programs had been more adequate. Indeed, we asked the program directors to give a full academic half-day (four hours) for participation in the study, but we know that at least one program gave their residents only two hours of protected time instead of four, which

potentially decreased the participation rate of this study. Indeed, the participation rate in the programs where an adequate amount of protected time was given was definitely higher. Results of the previously referenced EL-COVID survey also showed that attendance for e-Learning activities during the pandemic was sometimes difficult due to a lack of time because of the increased workload.¹² Nevertheless, we were still able to show significant improvements in knowledge during this activity, but perhaps with a larger sample size, we would have also been able to demonstrate significant differences when looking at behavior change.

Another limitation of the study is that the evaluation of behavior was self-reported. This might have resulted in an overestimation of compliance to the guidelines in the pre-intervention survey, and therefore we were not able to show statistically significant differences when comparing with the post-intervention survey. In this study we decided to use self-reports of behavior change as it was more convenient because study participants were scattered in different residency programs across Canada, and because the COVID-19 pandemic limited the possibility of traveling to these locations, or of having multiple external evaluations (in person) by a supervisor to see if learners' behavior had changed during the study period. That being said, future research looking at this topic should consider using objective evaluation criteria with standardized assessment tools pre- and post-intervention to increase the validity of this evaluation.¹⁵

Finally, the response rate to the follow-up survey, which was used to evaluate differences in behavior, was only 71% (15/21). This might also partially explain why it was more challenging to show statistically significant behavior changes. Survey fatigue is a well-described phenomenon in educational and health sciences research.²⁹ Our study used 3 different surveys (pre-intervention, satisfaction, and post-intervention/follow-up) and therefore it is possible that response rates to the third survey were suppressed because of survey fatigue.²⁹ Also, during the COVID-19 pandemic,

survey fatigue has been shown to be even more significant because of the sudden increase in surveys being sent out to compensate for the decrease in the possibility to conduct research that required face-to-face interactions.³⁰ This might have also affected our response rate.

4.6 Conclusion

The objectives of this study were to design a curriculum, tailored for the needs of vascular surgery trainees, and to evaluate learning on three different levels Kirkpatrick's Four Level Model of Learning Evaluation²¹ (*Figure 1*). For the first level of the pyramid, *Reaction*, we were able to demonstrate that the trainees unanimously appreciated this learning activity. Furthermore, the use of the Net Promoter Score and the collection of qualitative feedback allowed us to confirm that our learners would recommend this module to their peers and would like to participate in similar activities in the future. For the second level of the pyramid, *Learning*, we were also able to show a statistically significant gain in knowledge for the whole population of learners. An interesting finding was that junior and senior trainees had similar knowledge of the guidelines at baseline, but after engaging with the module, the senior learners had better scores on the post-intervention test, perhaps because they were able to link new information to previous experiences which allowed them to encode this new information more efficiently. For the third level of the pyramid, *Behavior*, we also found a significant difference in the use of the GLASS classification, but we were not able to show statistically significant differences in other domains such as the use of the Wifl classification or antiplatelet therapy prescription patterns. Overall, we believe that the implementation of this new educational activity in the curriculum of 5 Canadian vascular surgery residency programs was a success. The methods used in this study to create the module will most likely serve as a basis for the creation of similar activities in the future. To that effect, this study allowed us to demonstrate how important it is to pay attention to details when designing a

curriculum, from the needs analysis phase to the implementation, and the importance of allowing time for expert consultation and pilot testing in order to create successful educational activities. In conclusion, our study showed that online learning can be a powerful tool in surgical residency programs and that residents greatly appreciate this type of educational activity. More research using objective evaluation methods should be done to evaluate the effect of e-learning on inducing behavior change to prove the efficacy of e-learning in that specific area.

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APPENDICES

- A. Detailed Timeline of the Project
- B. Pre-Intervention Survey and Pre-Intervention Knowledge Check
- C. Post-Intervention Knowledge Check and Satisfaction Survey
- D. Follow-up Survey
- E. Ethics Approval

APPENDIX A

Appendix A: Project Timeline

First Year – Master of Medical Sciences in Medical Education 2019-2020 (Full-time)									
September	October	November	December	January	February	March	April	May	June
Literature Review Study Design									
		Search for Mentor		Search for Thesis Committee Members					
				Summarize Guidelines Content Create Online Curriculum Create Assessment Create Survey					
						IRB Application Process			
							1 st Thesis Committee Meeting		
									Pilot Testing of Online Curriculum

Second Year – Master of Medical Sciences in Medical Education 2020-2021 (+Fellowship)									
July	August	September	October	November	December	January	February	March	April
Revisions according to Pilot testing									
		Release Online Curriculum Data Collection				Distribute Follow-up Survey			
						2 nd Thesis Committee Meeting			
					Data Analysis				

Third Year – Master of Medical Sciences in Medical Education 2021-2022 (+Clinical Work)									
July	August	September	October	November	December	January	February	March	April
Thesis Manuscript Writing									
							Final Thesis Committee Meeting		

APPENDIX B

Introduction

PERMISSION TO TAKE PART IN A HUMAN RESEARCH STUDY:

You are being asked to take part in a research study.

This research is being conducted to learn about the efficacy of e-learning amongst vascular surgery trainees. Specifically, we are interested in learning about its use in increasing theoretical knowledge and inducing changes in practice patterns. You are being asked to participate in this research because you are currently enrolled in a Canadian or American vascular surgery residency program.

Your participation in this study is voluntary and you may withdraw your participation at any time for any reason.

If you take part in this study, you will be asked to complete an e-learning module on the management of chronic limb-threatening ischemia, which can be done during one of your designated academic half-day, and answer pre- and post-intervention surveys and knowledge checks. This process should take approximately 3-4 hours to complete.

The possible risk of participating in this study is breach of confidentiality in the data that we will be collecting. To prevent this, we will use password-protected documents to store any data collected in this study and we will provide you with an anonymous study participant ID number. The key to this ID number will only be known to you and the principal investigator. Also, individual test scores will not be disclosed to your program directors in order to prevent any negative impact on reputation or academic standing.

The benefits of participating in this study are:

- Learning best practices in management of chronic limb-threatening ischemia
- Learning new classification systems that are now considered the gold-standard for describing chronic limb-threatening ischemia and wounds
- Having access to a peer-reviewed educational activity
- Evaluating and reflecting on your own learning via pre- and post-intervention knowledge checks

- Having access to an educational activity that is interactive and stimulating in the context of a global pandemic which reduces the accessibility to traditional didactic sessions

You can decline to participate in any part of this study for any reason and can end your participation at any time.

If you have any questions about this study, you can contact the principal investigator, Dr. Julien Bernatchez, via e-mail at julien_bernatchez@hms.harvard.edu or by phone at 581-980-3377.

Thank you again for your time and participation.

If you agree to participate in this study, please enter today's date and your study participant ID below and click the arrow button to access the pre-intervention survey.

Participant ID

Date (YYYY/MM/DD)

Which of the following represents your current situation?

- ☐ First-year resident (PGY-1)
- ☐ Second-year resident (PGY-2)
- ☐ Third-year resident (PGY-3)
- ☐ Fourth-year resident (PGY-4)
- ☐ Fifth-year resident (PGY-5)
- ☐ Clinical Fellow
- ☐ Attending

Have you read the 2019 Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischemia (published in the Journal of Vascular Surgery in June 2019)?

- ☐ Yes

☐ No

Classification of limb severity

What classification system do you use the most frequently to stage peripheral artery disease severity?

- ☐ Fontaine
- ☐ Rutherford
- ☐ SVS threatened limb classification system (Wlfl score)
- ☐ TASC II
- ☐ Other

Have you ever used the Wlfl score to stage peripheral artery disease severity?

- ☐ Yes
- ☐ No
- ☐ I don't know what the Wlfl score is

Over the last 2 months, how often did you use the SVS threatened limb classification system (Wlfl score) to stage peripheral artery disease severity?

- ☐ Never
- ☐ Sometimes
- ☐ About half the time
- ☐ Most of the time
- ☐ Always

How important do you believe the SVS threatened limb classification system (Wlfl score) is in helping you evaluate the **amputation risk** of your CLTI patients?

- ☐ Not at all important
- ☐ Slightly important

- ☐ Moderately important
- ☐ Very important
- ☐ Extremely important

How important do you believe the SVS threatened limb classification system (Wlfl score) is in helping you evaluate the **need for revascularization** of your CLTI patients?

- ☐ Not at all important
- ☐ Slightly important
- ☐ Moderately important
- ☐ Very important
- ☐ Extremely important

Classification of disease patterns

Have you ever used the Global Anatomic Staging System (GLASS) to describe peripheral artery disease patterns?

- ☐ Yes
- ☐ No
- ☐ I don't know what GLASS is

Over the last 2 months, how often did you use the Global Anatomic Staging System (GLASS) to describe peripheral artery disease patterns?

- ☐ Never
- ☐ Sometimes
- ☐ About half the time
- ☐ Most of the time
- ☐ Always

Over the last 2 months, how often did you use the Global Anatomic Staging System (GLASS) to evaluate the technical complexity of endovascular interventions?

- ☐ Never
- ☐ Sometimes
- ☐ About half the time
- ☐ Most of the time
- ☐ Always

Antithrombotic prescriptions

For a patient with low bleeding risk, what antithrombotic therapy do you usually prescribe following an **endovascular** revascularization?

Please enter your answer as you would write it on a prescription for the pharmacy (stating dosage, frequency and duration of treatment)

For a patient with low bleeding risk, what antithrombotic therapy do you usually prescribe following a **venous** bypass procedure?

Please enter your answer as you would write it on a prescription for the pharmacy (stating dosage, frequency and duration of treatment)

For a patient with low bleeding risk, what antithrombotic therapy do you usually prescribe following a **prosthetic** bypass procedure?

Please enter your answer as you would write it on a prescription for the pharmacy (stating dosage, frequency and duration of treatment)

Default Question Block

PRE-INTERVENTION KNOWLEDGE CHECK:

The following knowledge check contains 27 questions.

Please answer all of them to the best of your knowledge without referring to textbooks or guidelines.

Please write down the identification number that was sent to you in the e-mail inviting you to complete this study:

1. Which of the following patient subpopulation was excluded from the initial definition of Critical Limb Ischemia (CLI), but is now included in the new definition of Chronic Limb Threatening Ischemia (CLTI)?

- ☐ Patients with diabetes mellitus
- ☐ Patients with chronic kidney disease
- ☐ Patients with Buerger's disease
- ☐ Patients with ischemic rest pain but no tissue loss

2. Name the **two (2)** requirements for diagnosis of Chronic Limb Threatening Ischemia (CLTI).

3. Which of the following peripheral artery disease risk factors are strongly associated with a predominantly **distal** disease pattern? (*Select all that apply*)

- ☐ Diabetes Mellitus
- ☐ Smoking
- ☐ Chronic kidney disease
- ☐ Age
- ☐ Hypertension
- ☐ Hypercholesterolemia

4. What is the hemodynamic criteria cutoff associated with diagnosis of CLTI?

a. For Ankle-Brachial Index (ABI)

b. For Ankle Pressure (AP)

c. For Toe Pressure (TP)

5. In the COMPASS and VOYAGER PAD trials, which of the following anti-thrombotic treatment regimen was shown to be superior in the prevention of major adverse cardiovascular and limb events (MACEs and MALEs)?

- ☐ Aspirin alone
- ☐ Aspirin once daily + Clopidogrel once daily
- ☐ Aspirin once daily + Rivaroxaban 2.5mg twice daily
- ☐ Aspirin once daily + Rivaroxaban 5mg once daily
- ☐ Aspirin once daily + Rivaroxaban 5mg twice daily

6. Which of the following hypoglycemic medication is not recommended in patients with peripheral artery disease because of the increase in amputation risk?

- ☐ Metformin
- ☐ Canagliflozin
- ☐ Dapagliflozin
- ☐ Gliclazide
- ☐ Saxagliptine

7. When ankle pressure and/or ABI are discordant with clinical presentation

a. What is most likely the cause?

b. What should be the next step in the investigation?

8. A patient is referred to your clinic with ischemic rest pain and no tissue loss. His ABI is 0.4 and his TP is 31mmHg. He has no symptoms or signs of infection. Identify the Wound, Ischemia, and foot Infection grades as defined by the SVS WIfI classification system. (Submit your answer as W#I#fI#)

9. A patient with previous history of toe amputations for diabetic foot ulcerations presents to the emergency department with a fever of 39.1 degrees celsius, he is tachycardic. Upon examination of the foot, the probe to bone is positive at the level of the first metatarsal head and pus is evacuating from the wound. His doppler shows triphasic waveforms at the ankle with toe pressure of 68mmHg. This is what you see:



Identify the Wound, Ischemia, and foot Infection grades as defined by the SVS Wifl classification system. *(Submit your answer as W#I#fI#)*

10. A patient is referred to your clinic with extensive heel and digits necrosis on his left foot as seen in the pictures below. His ABI is 0.34 and his AP is 42mmHg. He has no symptoms or signs of infection.



Identify the Wound, Ischemia, and foot Infection grades as defined by the SVS WIfI classification system. (Submit your answer as W#I#fI#)

11. For the last patient, what would be:

a. His Wifl clinical stage?

b. His risk of amputation at 1 year based on the Wifl stage?

12. Match the imaging modality with the correct description on the right:

Items

Magnetic Resonance
Angiography (MRA)

Digital Subtraction
Angiography (DSA)

Computed Tomography
Angiography (CTA)

Ideal for imaging of the aorto-iliac and femoro-popliteal segments but can have image interference from calcified arteries.

Also ideal for imaging of the aorto-iliac and femoro-popliteal segments, not affected by calcified arteries but has a tendency to overestimate stenosis.

Ideal for imaging of the infra-popliteal and pedal vessels.

13. What is the main focus of the GLASS classification?

- ☐ Predict the outcomes of surgical interventions in aorto-iliac atherosclerotic disease.
- ☐ Predict the outcomes of endovascular interventions in aorto-iliac atherosclerotic disease.
- ☐ Predict the outcomes of surgical interventions in infra-inguinal atherosclerotic disease.
- ☐ Predict the outcomes of endovascular interventions in infra-inguinal atherosclerotic disease.
- ☐ All of the above

14. What is the aorto-iliac disease grading of this patient according to the GLASS classification?

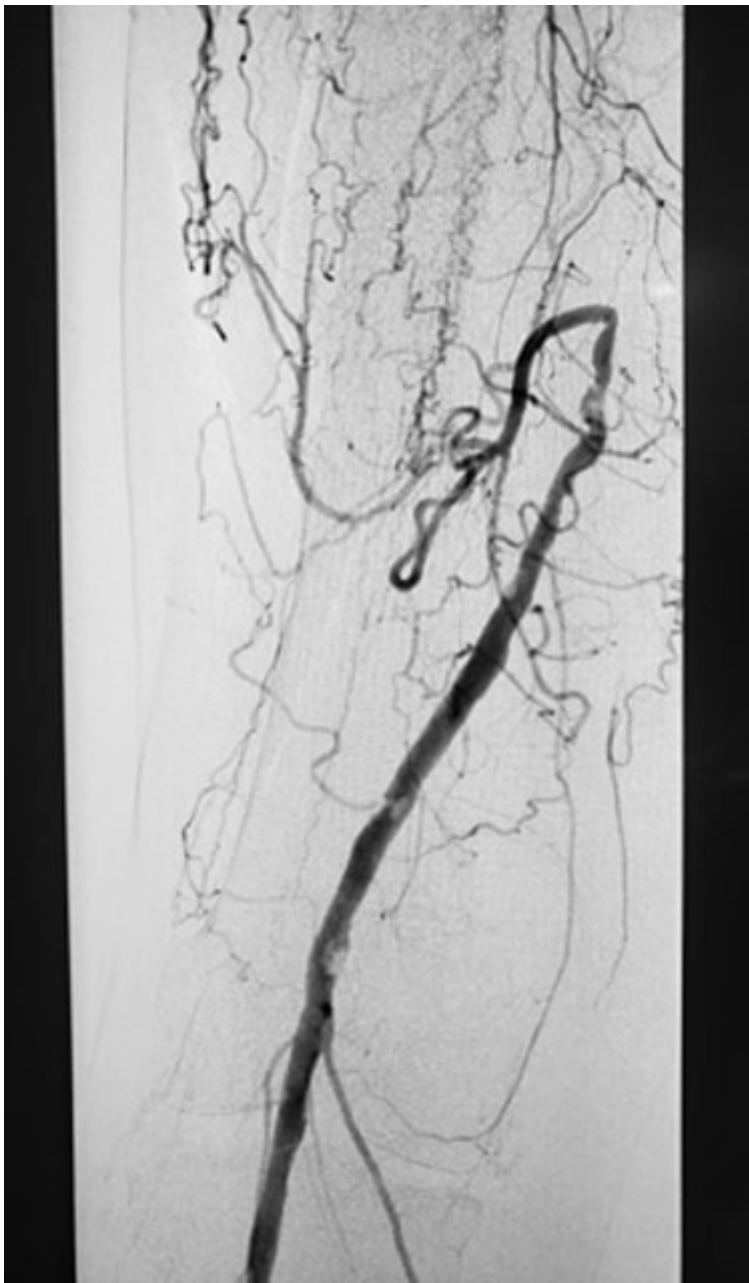


15. When using the GLASS classification, briefly describe how the Target Arterial Path (TAP) is selected?

16. What is the femoro-popliteal disease grading of this patient according to the GLASS classification?

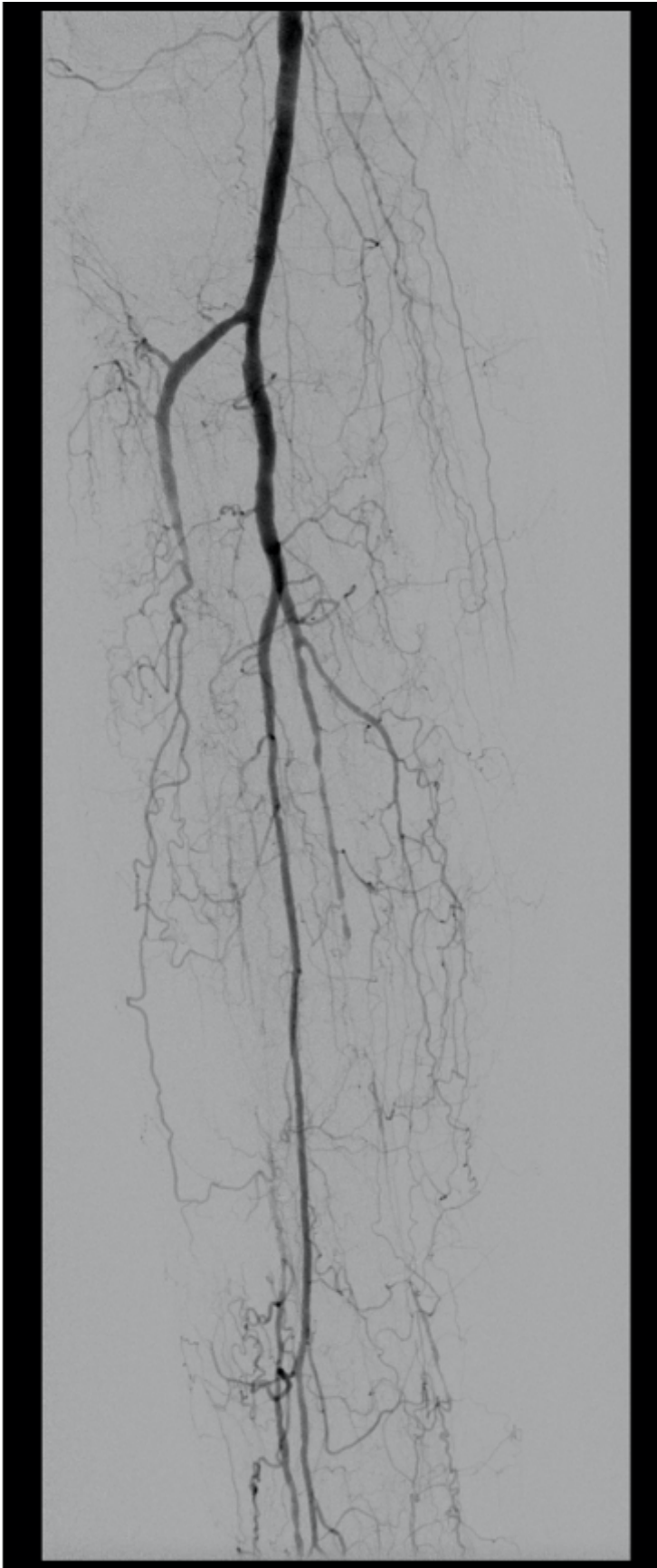
The length of the occlusion is 15cm.

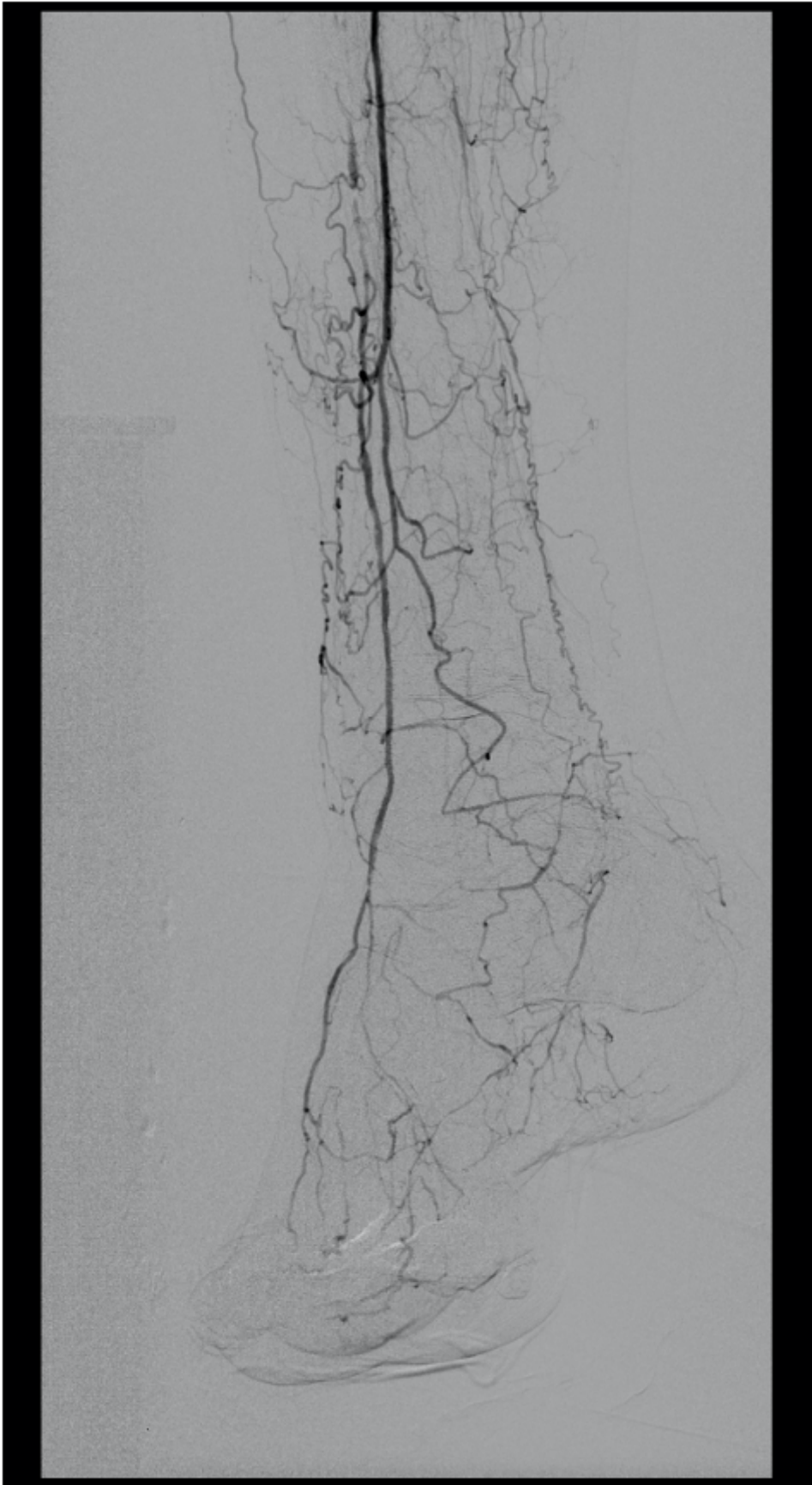




- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

17. What is the infra-popliteal disease grading of this patient according to the GLASS classification? In this case the chosen Target Arterial Path (TAP) was the anterior tibial artery.





- ☐ 1
- ☐ 2

☐ 3☐ 4

18. What are the **three (3)** components on the PLAN integrated approach to CLTI, as described in the 2019 Global Vascular Guidelines on the Management of CLTI?

19. Describe a situation where it would be reasonable to treat only inflow disease in a CLTI patient who has coexistent inflow and infra-inguinal disease.

20. In the aorto-iliac segment, what does the “modifier B” mean in the GLASS classification?

21. Name **two (2)** of the main findings of the BASIL (BASIL-1) trial.

22. Which of the following is **not** a recommendation the 2019 Global Vascular Guidelines for the Management of CLTI in the treatment of infra-inguinal disease

- ☐ When adequate venous conduit is not available, endovascular treatment is recommended instead of using prosthetic or biologic conduits.
- ☐ It is recommended to perform intraoperative completion imaging for bypass surgeries.

- ☐ In treating femoro-popliteal disease, stenting is considered the standard of care
- ☐ In the infrapopliteal segment, plain balloon angioplasty remains the standard of care.

23. Which of the following is not considered a “minor” amputation?

- ☐ Ray amputation
- ☐ Transmetatarsal amputation
- ☐ Syme’s amputation
- ☐ Lisfranc’s amputation
- ☐ Chopart’s amputation

24. Name **three (3)** situations where primary amputation should be considered in the context of CLTI.

25. When considering rehabilitation after a major amputation what is the increase in energy expenditure (in an approximate %) for ambulation after a:

BKA (below-knee amputation)

AKA (above-knee amputation)

26. What is the recommended period for dual anti-platelet therapy (DAPT) after an infra-inguinal endovascular intervention in a patient with low bleeding risk?

- ☐ DAPT is not recommended and aspirin alone is sufficient
- ☐ DAPT is recommended for at least 1 month
- ☐ DAPT is recommended for at least 6 months
- ☐ DAPT is recommended for at least 12 months

27. Name **two (2)** situations where additional imaging and/or reintervention should be considered in the context of bypass surveillance. (Please write any clinical or

hemodynamic criteria)

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APPENDIX C

Default Question Block

POST-INTERVENTION KNOWLEDGE CHECK

Thank you for taking part in this study.

The following knowledge check contains 27 questions.

Please answer all of them to the best of your knowledge without referring to textbooks or guidelines.

Please write down the identification number that was sent to you in the e-mail inviting you to complete this study:

1. Which of the following patient subpopulation was excluded from the initial definition of Critical Limb Ischemia (CLI), but is now included in the new definition of Chronic Limb Threatening Ischemia (CLTI)?

- ☐ Patients with diabetes mellitus
- ☐ Patients with chronic kidney disease
- ☐ Patients with Buerger's disease
- ☐ Patients with ischemic rest pain but no tissue loss

2. Name the **two (2)** requirements for diagnosis of Chronic Limb Threatening Ischemia (CLTI).

3. Which of the following peripheral artery disease risk factors are strongly associated with a predominantly **distal** disease pattern? *(Select all that apply)*

- ☐ Diabetes Mellitus
- ☐ Smoking
- ☐ Chronic kidney disease
- ☐ Age
- ☐ Hypertension
- ☐ Hypercholesterolemia

4. What is the hemodynamic criteria cutoff associated with diagnosis of CLTI?

a. For Ankle-Brachial Index (ABI)

b. For Ankle Pressure (AP)

c. For Toe Pressure (TP)

5. In the COMPASS and VOYAGER PAD trials, which of the following anti-thrombotic treatment regimen was shown to be superior in the prevention of major adverse cardiovascular and limb events (MACEs and MALEs)?

- ☐ Aspirin alone
- ☐ Aspirin once daily + Clopidogrel once daily
- ☐ Aspirin once daily + Rivaroxaban 2.5mg twice daily
- ☐ Aspirin once daily + Rivaroxaban 5mg once daily
- ☐ Aspirin once daily + Rivaroxaban 5mg twice daily

6. Which of the following hypoglycemic medication is not recommended in patients with peripheral artery disease because of the increase in amputation risk?

- ☐ Metformin
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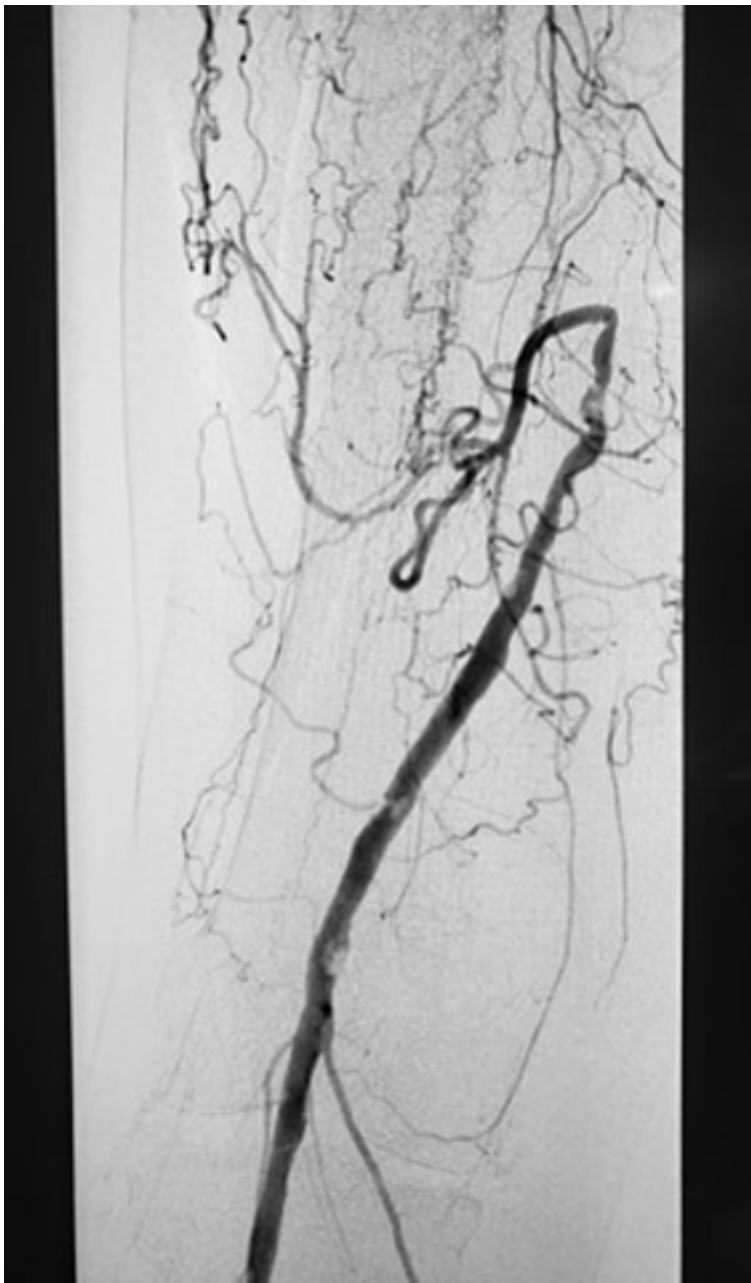


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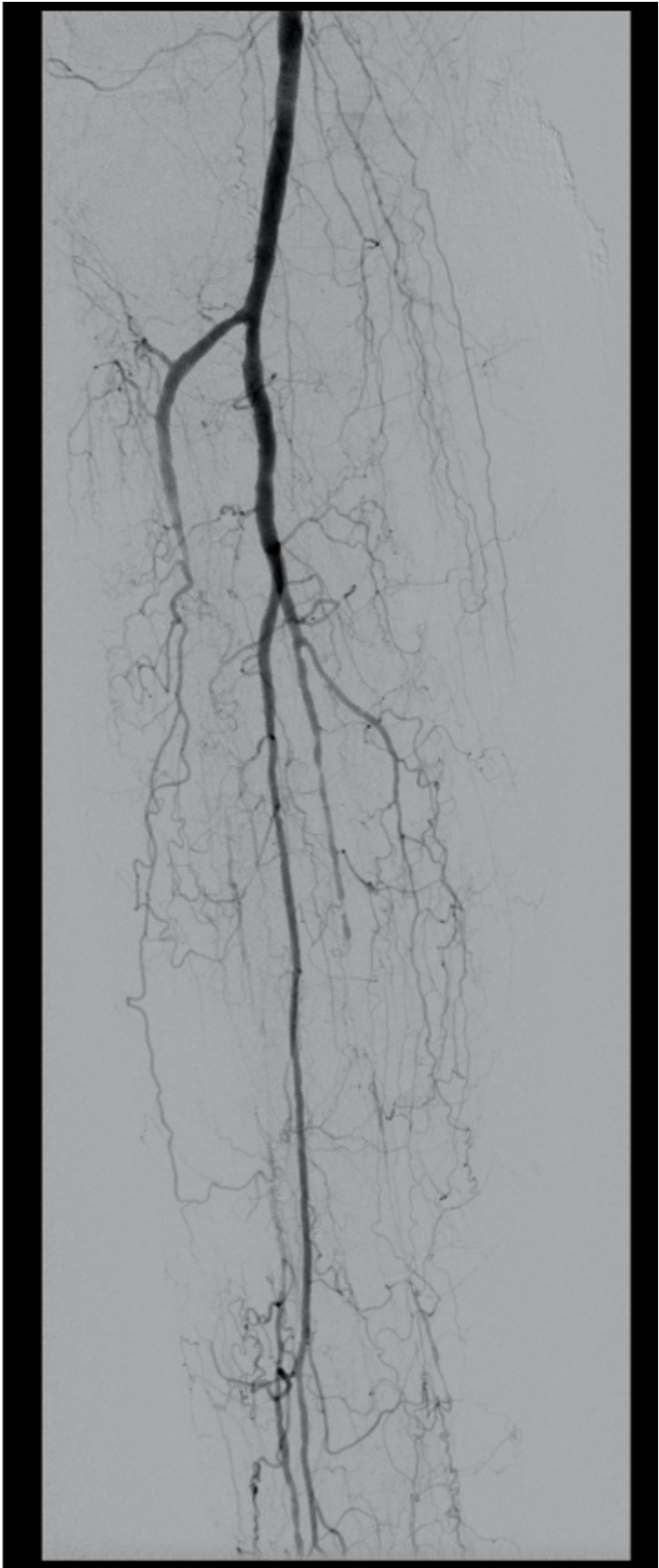
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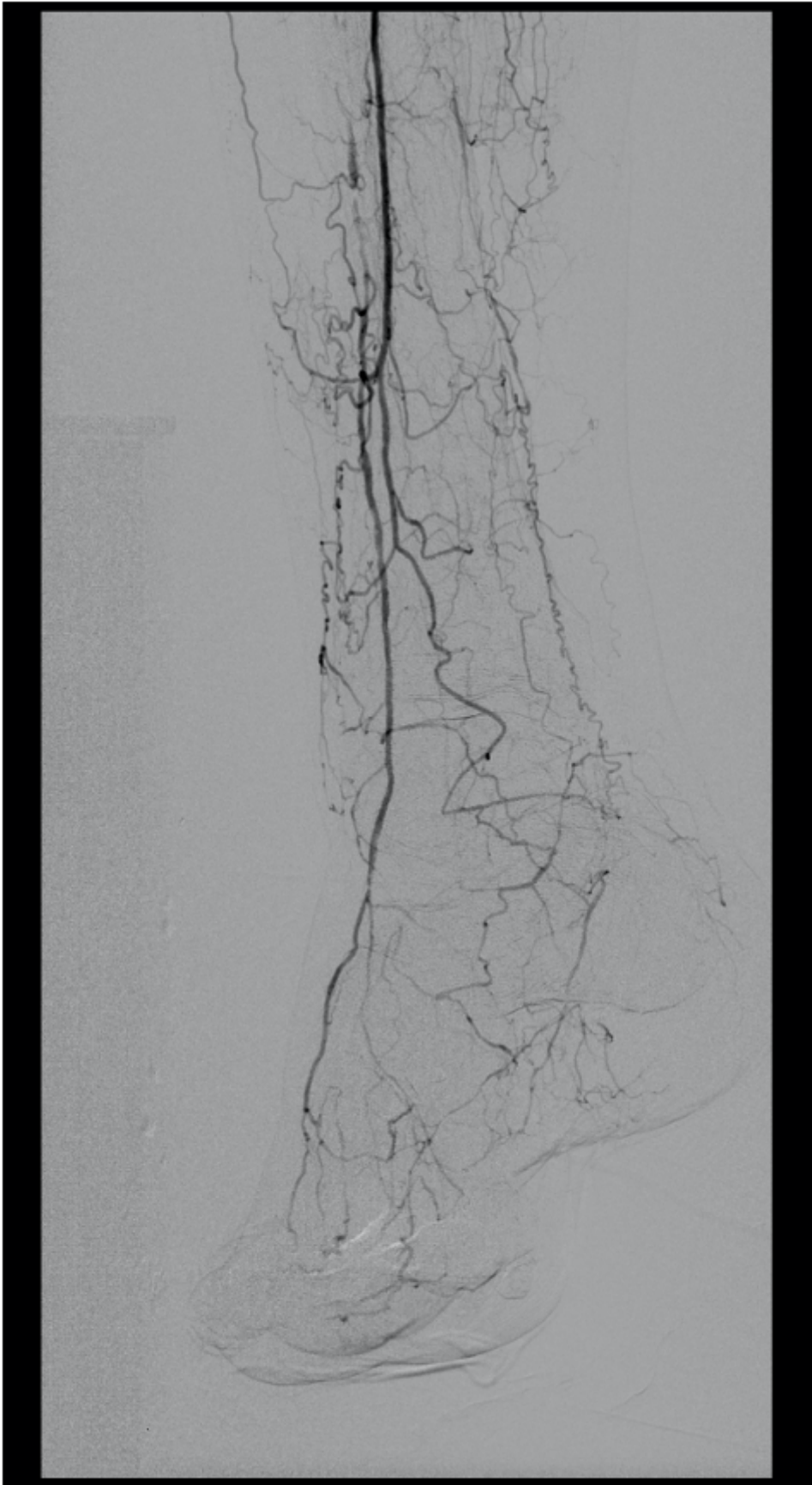




- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

17. What is the infra-popliteal disease grading of this patient according to the GLASS classification? In this case the chosen Target Arterial Path (TAP) was the anterior tibial artery.





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Default Question Block

Please write down the identification number that was sent to you in the e-mail inviting you to complete this study:

How would you rate the overall usefulness of the Articulate module "Management of Chronic Limb-Threatening Ischemia" for your learning?

- ☐ Not at all useful
- ☐ Slightly useful
- ☐ Moderately useful
- ☐ Very useful
- ☐ Extremely useful

Please rate the usefulness of each of these components of the module in your learning process:

	Not very useful	Slightly useful	Moderately useful	Very useful	Extremely useful
Written text	☐	☐	☐	☐	☐
Videos	☐	☐	☐	☐	☐
Audio commentaries	☐	☐	☐	☐	☐
Embedded quizzes	☐	☐	☐	☐	☐
Clinical cases	☐	☐	☐	☐	☐
Pre and Post-test	☐	☐	☐	☐	☐

How would you rate the ease of use of the module?

- ☐ Very difficult

- ☐ Somewhat difficult
- ☐ Neither easy nor difficult
- ☐ Somewhat easy
- ☐ Very easy

How much time did you spend going through the content of the module?

- ☐ Less than 2 hours
- ☐ 3-4 hours
- ☐ 5-6 hours
- ☐ 7 hours or more

How would you rate your overall satisfaction level with the module?

- ☐ Very dissatisfied
- ☐ Somewhat dissatisfied
- ☐ Neither satisfied nor dissatisfied
- ☐ Somewhat satisfied
- ☐ Very satisfied

How likely would you be to re-engage in similar activities (online modules on summarizing clinical guidelines) in the future?

- ☐ Very unlikely
- ☐ Somewhat unlikely
- ☐ Neither likely nor unlikely
- ☐ Somewhat likely
- ☐ Very likely

How likely would you be to recommend this module to a colleague?

Not at all likely

Extremely likely

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Please share any additional comments or suggestions for improvement of this module.

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APPENDIX D

Introduction

Please write down the identification number that was sent to you in the e-mail inviting you to complete this study:

Which of the following represents your current situation?

- ☐ First-year resident (PGY-1)
- ☐ Second-year resident (PGY-2)
- ☐ Third-year resident (PGY-3)
- ☐ Fourth-year resident (PGY-4)
- ☐ Fifth-year resident (PGY-5)
- ☐ Clinical Fellow
- ☐ Attending

Classification of limb severity

What classification system do you use the most frequently to stage peripheral artery disease severity?

- ☐ Fontaine
- ☐ Rutherford
- ☐ SVS threatened limb classification system (Wifl score)
- ☐ TASC II
- ☐ Other

Over the last 2 months, how often did you use the SVS threatened limb classification system (Wlfl score) to stage peripheral artery disease severity?

- ☐ Never
- ☐ Sometimes
- ☐ About half the time
- ☐ Most of the time
- ☐ Always

How important do you believe the SVS threatened limb classification system (Wlfl score) is in helping you evaluate the **amputation risk** of your CLTI patients?

- ☐ Not at all important
- ☐ Slightly important
- ☐ Moderately important
- ☐ Very important
- ☐ Extremely important

How important do you believe the SVS threatened limb classification system (Wlfl score) is in helping you evaluate the **need for revascularization** of your CLTI patients?

- ☐ Not at all important
- ☐ Slightly important
- ☐ Moderately important
- ☐ Very important
- ☐ Extremely important

Classification of disease patterns

Over the last 2 months, how often did you use the Global Anatomic Staging System (GLASS) to describe peripheral artery disease patterns?

- ☐ Never

- ☐ Sometimes
- ☐ About half the time
- ☐ Most of the time
- ☐ Always

Over the last 2 months, how often did you use the Global Anatomic Staging System (GLASS) to evaluate the technical complexity of endovascular interventions?

- ☐ Never
- ☐ Sometimes
- ☐ About half the time
- ☐ Most of the time
- ☐ Always

Antithrombotic prescriptions

For a patient with low bleeding risk, what antithrombotic therapy do you usually prescribe following an **endovascular** revascularization?

Please enter your answer as you would write it on a prescription for the pharmacy (stating dosage, frequency and duration of treatment)

For a patient with low bleeding risk, what antithrombotic therapy do you usually prescribe following a **venous** bypass procedure?

Please enter your answer as you would write it on a prescription for the pharmacy (stating dosage, frequency and duration of treatment)

For a patient with low bleeding risk, what antithrombotic therapy do you usually prescribe following a **prosthetic** bypass procedure?

Please enter your answer as you would write it on a prescription for the pharmacy (stating dosage, frequency and duration of treatment)

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APPENDIX E



HARVARD

Human Research Protection Program

Harvard Faculty of Medicine
Office of Regulatory Affairs and Research Compliance
90 Smith Street, 3rd Floor
Boston, MA 02120
Federalwide Assurance FWA00007071

Notification of Initial Study Exemption Determination

July 22, 2020

Julien Bernatchez
julien_bernatchez@hms.harvard.edu

Protocol Title:	Evaluation of the Efficacy of Online Learning for Increasing Theoretical Knowledge and Inducing Behavior Change Amongst Vascular Surgery Trainees
Principal Investigator:	Julien Bernatchez
Protocol #:	IRB20-1299
Funding Source:	None
IRB Review Date:	7/22/2020
IRB Effective Date:	7/22/2020
IRB Review Action:	Exempt

This Initial Study submission meets the criteria for exemption per the regulations found at 45 CFR 46.104(d) (2)(1). As such, additional IRB review is not required.

The Principal Investigator is responsible for ensuring compliance with any applicable local government or institutional laws, legislation, regulations, and/or policies, whether conducting research internationally or nationally. Additionally, if local IRB/ethics review is required, it must be obtained before any human subjects research activities are conducted in the field. If assistance with applicable local requirements is needed, please contact the Harvard Faculty of Medicine IRB office.

The determination that your research is exempt does not expire, and you will not file annual renewals. If changes to the research are proposed that would alter the IRB's original exemption determination, they should be submitted in ESTR by using the Modify Study button. If unsure, contact the Harvard Faculty of Medicine IRB office.

The IRB made the following determinations:

- Research Information Security Level (based on Harvard Research Data Security Policy): Non-Sensitive

Please contact me at 617.432.8382 or eehrlich@hsph.harvard.edu with any questions.

Sincerely,



HARVARD

Human Research Protection Program

Elizabeth Ehrlich
IRB Review Specialist