The Current State of the 0+5 Integrated Vascular Surgery Residency Training Paradigm: A Scoping Review of the Literature

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BACKGROUND: The 0+5 integrated vascular surgery residency program (IVSR) was introduced as a training model toward board certification in vascular surgery over 10 years ago. The pros and cons of this training model have been debated.

OBJECTIVE: The purpose of this review is to investigate, using qualitative methods, what is known about the development, implementation, and outcomes of the IVSR paradigm.

DESIGN: A systematic search of the literature pertaining to the IVSR training model was conducted to include literature from 2005 to 2016. A search strategy involving use of 4 literature databases, 4 search terms, and 4 inclusion criteria was used. Three independent reviewers screened titles and abstracts for inclusion. Data abstraction was performed by 1 reviewer. Qualitative content analysis was completed using the method of constant comparative analysis associated with a grounded theory design by all 3 reviewers.

RESULTS: Of 890 articles initially identified, 33 articles were found to meet inclusion criteria for full review. Nineteen (57%) were research articles with an average Medical Education Research Study Quality Instrument score of 6.3 out of 18. The remaining articles were categorized as editorials, presidential addresses, invited commentaries, and historical summaries. Three major themes related to the IVSR program were identified: context of program development, processes of the program once implemented, and outcomes.

CONCLUSIONS: The literature on the IVSR paradigm reflects contextual, process, and outcome issues. Research articles are of generally low quality and there is a paucity of analyses of outcome issues. Further research is recommended to identify and understand the outcomes of the model. (J Surg Ed 76:990–1004. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: 0+5, integrated vascular surgery residency, education, scoping review

COMPETENCIES: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement

INTRODUCTION

Graduate surgical education is changing, with increasing social, health system, and financial pressures to streamline training through early specialization in general surgery and the surgical subspecialties. The "0+5" or "integrated" vascular surgery residency (IVSR) program is designed to meet this demand for a focused and streamlined graduate surgical paradigm to train surgeons in predominantly vascular surgery skills over a period of 5 years. This program serves as an alternative model to the traditional "5+2" or "fellowship" in vascular surgery that focused the majority of time on general surgery (5 years) with only 2 years dedicated to vascular surgery. The implications of changing the traditional paradigm are a subject of research and debate.

IVSR's were introduced in 2006.[1] Multiple rationales were put forth, including assertion of the independence of the specialty, as well as social, financial, technical,

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and marketing rationales. The overarching aspiration was to attract the best and the brightest of medical students to an innovative and shorter residency education program. The health system rationale was that vascular surgery was evolving into a very distinct open and endovascular skill set and had moved in its practice significantly away from the skills considered mainstream for general surgery. Concomitantly, the Residency Review Committee (RRC) in general surgery indicated that their trainees would not need to have a very broad range of defined vascular surgery procedural skills. The financial rationale is that this program provided for an earlier entry into the professional workforce and thus a presumed reduction in personal and family debt burden.

It has been over 10 years since the first IVSR programs welcomed their inaugural residents. There has been widespread adoption of this model, with 55 accredited programs as of 2018, some of which replaced traditional fellowship programs at their GME site.[2] Objective and independent outcomes data are lacking, however, and no robust education research evaluation has been conducted. Subjectively, there are mixed perceptions about the value of the IVSR program within professional ranks. This decade-long and ongoing debate reveals a gap in our knowledge about the processes and outcomes of these programs.

The purpose of this review is to use a mixed methods approach, quantitative and qualitative, to evaluate the current body of literature related to the development, implementation and outcomes of the IVSR training paradigm. This review is an essential first step in an evaluation of the paradigm shift.

This study is designed to address 3 specific purposes: (1) to identify prominent and recurring themes in the literature on the 0+5 integrated vascular surgery training paradigm, (2) to review and describe what is known about the development, implementation, and outcomes of the IVSR programs, and (3) to make recommendations for future work to evaluate the IVSR training paradigm.

METHODS

An emerging methodology for review of the literature, the "scoping review," has been described as "a form of knowledge synthesis that addresses a research question designed to map key concepts, types of evidence and gaps in research related to a defined area or field by systematically searching, selecting and synthesizing existing knowledge."[3] In 2005, Arksey and O'Malley described a conceptual framework to inform the process of conducting a scoping review.[4] This 6-step approach begins with formulating the research question, searching for relevant studies, followed by selection of studies for inclusion, charting the data, summarizing and reporting results, and finally, consideration of needed consultation. The scoping review is best suited to emerging areas of study for which a description of the overall landscape of what is known can help to map and synthesize existing knowledge and provide insight regarding gaps.

We have applied this framework in the current study to conduct a scoping review of the literature to determine what is known about the development, implementation and outcomes of the 0+5 IVSR training paradigm.

Information Sources and Search Strategy

After formulating the research question, we proceeded to identify relevant studies. This was undertaken with the guidance of a trained librarian and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards for systematic reviews (Fig. 1). The literature search included both published and grey literature presented between 1996 and 2016. The first 0+5 program was implemented in 2006, so we selected 10 years prior to this as the inclusion cut-off in an effort to capture any literature pertaining to program conceptualization and development. Search terms included "vascular surgery," "residency education," "integrated vascular surgery residency," and "0+5 vascular surgery residency."

Our initial search of Ovid Medline, EMBASE, Scopus and ERIC on October 27th, 2016, generated 1129 relevant titles, which were reduced to 890 after removal of duplicates. Two additional articles were identified via hand search of article references.

Study Selection Process

Our research questions specifically pertain to the development, implementation, and outcomes of the IVSR program. These questions were kept in mind as titles and abstracts were reviewed to determine appropriateness for inclusion. As we gained knowledge of the available literature, the inclusion, and exclusion criteria were refined in an iterative process.

Articles published from 1996 to the present were included in the initial search. Articles had to include a reference to "0+5" or "integrated" vascular surgery training anywhere within the manuscript. All study designs were included, as well as nonresearch publications, such as commentaries and presidential addresses. Major exclusion criteria were lack of availability in the English language and published prior to 1996. Papers included research studies, review articles, opinion articles, and transcripts of public speeches.

Title and Abstract Review

The primary author (BS) reviewed the titles of the 890 articles captured by the search and removed obviously

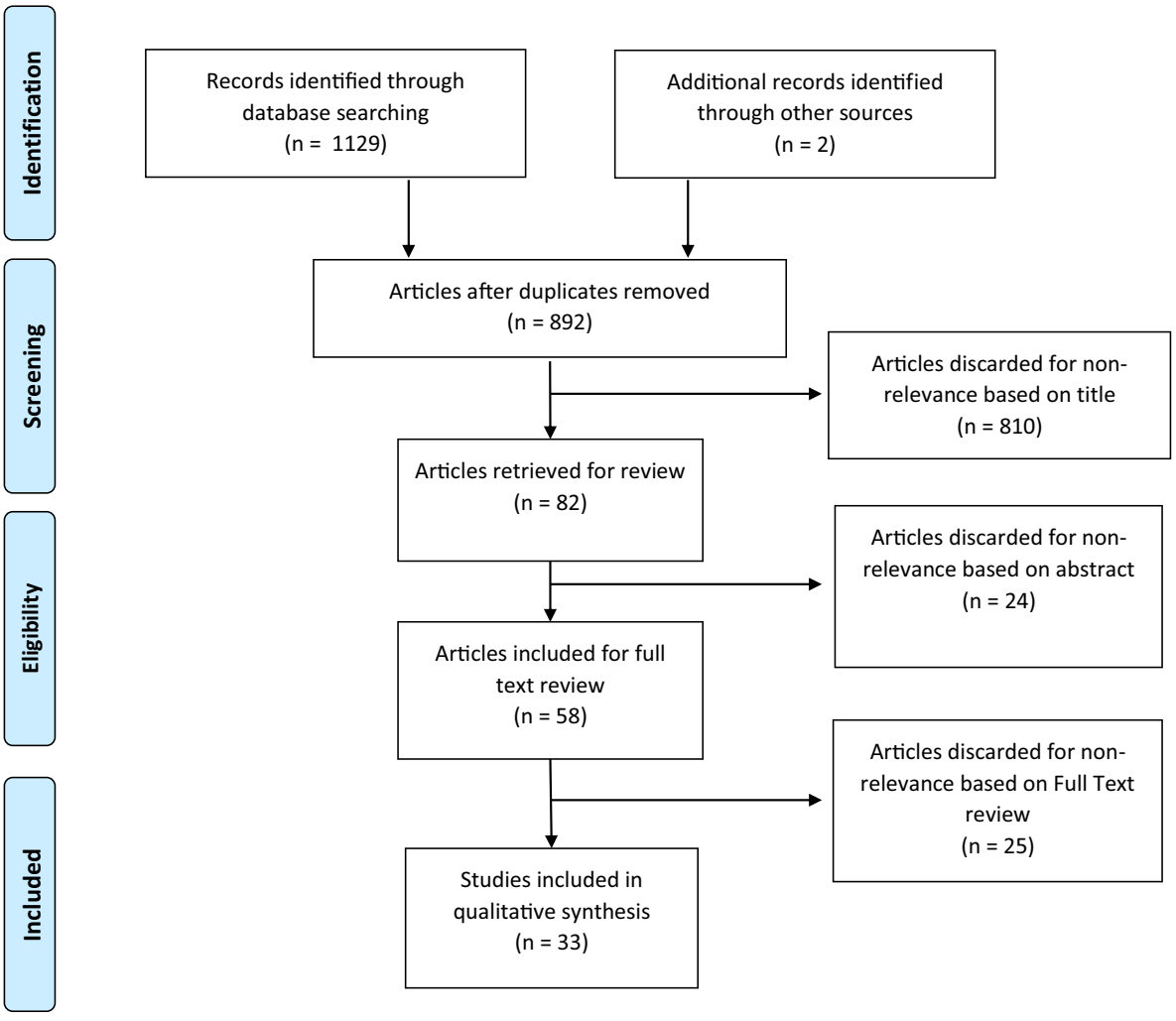

FIGURE 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for scoping review process. ("Screened" = title and abstract (when available) reviewed).

irrelevant titles, resulting in 82 remaining articles. All 3 study authors (BS, MD, and IH) then reviewed the abstracts of the remaining articles and voted as to whether or not the study should be included. Discrepant opinions were discussed until consensus was reached. If consensus could not be reached, the article was maintained for review of the full text. After review and discussion of abstracts, 58 articles remained for full text review. Upon full text review, the 3 study authors repeated the consensus process, resulting in the elimination of 25 additional articles, leaving 33 articles for inclusion in the scoping review.[1,5-36]

Data Extraction and Analysis

The 33 articles included for analysis were reviewed by all 3 authors. Prior to data extraction, a data chart was created to capture pertinent information about each article. We collected information related to the research questions, study design and methods, results, major themes, limitations, and conclusions. Themes were identified using the method of constant comparative approach associated with a grounded theory design.

METHODOLOGY QUALITY APPRAISAL

Synthesis

The synthesis included both quantitative and qualitative analysis of the included articles. Quantitative analyses included frequency analysis of the type of articles and descriptive statistics of Medical Education Research Study Quality Instrument (MERSQI) scores.[37]

For the qualitative analysis, the study authors independently conducted thematic analysis of the content of the articles, identifying major themes and subthemes using, as indicated, the method of constant comparative analysis.

Themes were then discussed by the team. After agreement on core themes, relevant units of text from the articles were coded. The preliminary results were then discussed and overarching themes and subthemes formulated.

RESULTS

Literature Search

Study Characteristics

Thirty-three articles were included in the final analysis (Table 1). Nineteen articles (57%) were research studies with a defined research question. The methodologies of the research articles included 13 survey-based 5 retrospective reviews of a prospective database, and 1 qualitative analysis. Average MERSQI score of the research articles was 6.3 out of 18 possible points (range 5.5-9.0). Of the remaining 15 articles, 7 (20%) were opinion editorials, 4 (11%) published presidential addresses, 2 (6%) invited commentaries, and 1 (3%) historical summary.

Qualitative Analysis

Qualitative analysis of the content of the articles revealed themes addressing context, process, and outcome issues of the IVSR program. Content related to "context" included discussion of the need for planning and design of the IVSR model. Content related to the "process" of the program included discussions of how the program is actually occurring once implemented. Evaluation of program curricula, assessment of learners, and reporting of interim program outcomes are included in this theme. Finally, content related to the "outcome" of the IVSR program includes assessment of graduates and evaluation of the complete program from start to finish. Subthemes within each of these categories were identified and are outlined in Table 2. Research articles are summarized in Table 3 and nonresearch articles are summarized in Table 4.

Context

The context surrounding and informing the need to create the IVSR program is a prominent theme discussed in the literature. Subthemes related to context include politics and professional identity, trainee satisfaction with existing vascular surgery training programs, workforce needs of the specialty, and the opportunity to create innovative training models. Contextual evaluation was the most common type of article and theme discussed. Articles addressing contextual factors influencing program development were primarily nonresearch articles, including presidential addresses and opinion editorials.

TABLE 1. Types of Articles Included for Analysis in the Final Scoping Review

Type of Article	N (%)
Research	19 (57)
Opinion editorials	7 (20)
Presidential address	4 (11)
Invited commentary	2 (6)
Historical summary	1 (3)
Total	**33**

The need to create the IVSR program appears to have been strongly influenced by the political landscape of the time. Authors discuss a desire for Vascular Surgery to be an independent specialty with control over recruitment, training programs, and the professional identity of the specialty. Zimmerman and colleagues expressed that "[Leaders in vascular surgery] must grow the profession at a critical juncture in which our identity is changing with the evolving technology, ownership within the endovascular sphere is not well established, and alterations in training are necessary to prepare the new vascular specialist for the future." Creation of a training model that was completely under the control of a Vascular Surgery Board, removing General Surgery from the equation, was viewed as a critical step toward independence.

> "Vascular surgery in the year 2005 is at a crossroads. Trends in demographics, workforce, technology, public opinion, and public policy will lead to more accountability and to greater autonomy at the same time...But we will also enjoy a new level of autonomy to control our destiny as a specialty and to direct the educational paths of the generations who follow us."
>
> (Sicard, 2005)

> "...[0+5] offers the best hope for the future of vascular surgery and it is the only viable educational rubric that identifies VS as a truly independent specialty"
>
> (Stanley, 2006)

The number and quality of applicants to the 5+2 program demonstrated a decreasing trend and it was believed that the 5+2 program was becoming less desirable due to the duration of training.[36] Seeger and colleagues note that "while the current training system has produced vascular surgeons who are well trained... it is too long and too ill-focused to be appealing to current graduates of our medical schools."[30] Length of training was only reported as a deterrent to pursuing the specialty by medical students, however.[1]

> "The protracted training period and large incurred debt were strong disincentives for medical students and residents to pursue vascular surgery...in the

TABLE 2. Definition of Themes and Representative Quotations

Theme	Definition	Subthemes	Representative Quotations
Context	Evaluation of the need for the IVSR program and discussion related to the planning and design of the IVSR model.	• Trainee Satisfaction and Recruitment • Workforce needs • Politics and Professional Identity • Advancing Technology • Innovative Program • Uncertainty	"Vascular surgery in the year 2005 is at a crossroads. Trends in demographics, workforce, technology, public opinion, and public policy will lead to more accountability and to greater autonomy at the same time. . .But we will also enjoy a new level of autonomy to control our destiny as a specialty and to direct the educational paths of the generations who follow us." (Sicard, 2005) "[Leaders in vascular surgery] must grow the profession at a critical juncture in which our identity is changing with the evolving technology, ownership within the endovascular sphere is not well established, and alterations in training are necessary to prepare the new vascular specialist for the future." (Zimmerman, 2006)
Process	Evaluation of the IVSR program as it is actually occurring. Includes discussion related to assessment of learners, evaluation of program curricula and interim outcomes.	• Trainee Satisfaction • Comparison of 0+5 and 5+2 • Curriculum Design • Recruitment Success • Uncertainty	". . .the demand for [IVSR program] has exceeded that of the traditional vascular surgery fellowship by nearly 10-fold." (Schanzer, 2009) ". . .nobody knows how ready the trainees are going to be for the world." (Smith, 2014) ". . .both [IVSR] and [fellowship] trainees are reaching acceptable milestones in knowledge base and surgical skills for graduation. However,. . .[IVSR] trainees' milestones remain consistently lower than [fellowship] trainees' milestones." (Macsata, 2016)
Outcome	Evaluation of the outcomes of the IVSR program. This includes discussion related to assessment of graduates and evaluation of the complete program from start to finish.	• Trainee Satisfaction • Comparison of 0+5 and 5+2 • Community Perception • Uncertainty	"The [VSF] experience is clearly superior [to the IVSR] in overall case numbers, although there is a large contribution from general surgical training." (Batista, 2015) "Measured by operative experience and satisfaction with their training curriculum, there does not appear to be a significant difference between the two types of VS graduates." (Colvard, 2015)

2004 and 2005 vascular surgery matches, there were insufficient applicants to fill the available positions."

(Mills, 2008)

The growing momentum toward independence of the specialty and the subsequent approval of the Primary Certificate in Vascular Surgery was generally viewed as an opportunity for educational innovation and flexibility in training options.

"The integrated residency in vascular surgery greatly increases the time spent learning vascular surgery and allows much greater freedom in developing a curriculum that is specific to the needs of the vascular surgery resident."

(Schanzer, 2009)

There is discussion of an aging workforce and an aging patient population, with an increasing need for more

TABLE 3. Summary of Research Articles

Article	Hypothesis or Research Question	Research Methodology	Population Studied	Results	Theme(s) Related to the IVSR Program	Conclusions	MERSQI Score
Zimmerman, 2006	When do VSF's choose Vascular Surgery?	Survey	VSF's in 2006	RR = 82% 59% of VSF's choose Vascular Surgery in the PGY3 or PGY4 year of GS Residency	Workforce needs Trainee satisfaction Recruitment Advancing tech Professional identity	Early exposure to VS is important to recruit the best candidates to the IVSR program.	7.0
Harris, 2007	"To identify factors influencing career decisions of female medical students."	Survey	Women third and fourth year medical students at 3 medical schools	RR = 39% Lifestyle and family issues are the primary obstacles to surgical careers	Workforce needs Recruitment Professional identity	To optimize recruitment, the VS community needs to plan and support mentorship of students.	6.0
Schanzer, 2009	To evaluate the demand for IVSR positions and applicant demographics	Retrospective review	2006-2009 AAMC data on IVSR and VSF applicants; single institution applicant review	2009: 88% of IVSR applicants did not match; 16% of VSF positions unfilled; IVSR applicants "stronger" than VSF applicants	Recruitment Innovative program Professional identity	VS should aggressively increase number of IVSR programs. If the IVSR meets the needs of residents, reevaluation of other 7 year training paradigms may be warranted.	5.5
Lee, 2010	To investigate the background and motivation of IVSR applicants for accelerated vascular training	Retrospective review and survey	IVSR applicants to Stanford; General Surgery applicants to UCLA	RR 81% of IVSR applicants and 60% of GS applicants IVSR applicant older, more publications, more likely to be in top of class and have additional degrees	Recruitment Innovative program Comparison	IVSR applicants are as good or better than GS applicants. Institutional strategies to increase medical student exposure to VS are important.	6.0
Reed, 2010	To determine who trains IVSR and VSF trainees endovascular techniques	Survey	IVSR and VSF trainees at the 2008 and 2009 VSITE	RR = 80% both groups Slightly more IVSR trainees taught by IR	Curriculum	Vascular surgeons provide >80% of endovascular training to IVSR and VSF trainees	7.0
Lee, 2011	To determine the impact of endovascular simulation on medical student performance and career choice	Survey	First and second year medical students at Stanford; 2008-2009	*N* = 52 pre-clinical medical students 9% interest in VS pre-sim, tripled post. Sustained interest in 25% of students	Workforce needs Recruitment Innovative program	Early exposure to VS and mentorship impacts career choices of medical students.	6.5

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TABLE 3 (*CONTINUED*)

Article	Hypothesis or Research Question	Research Methodology	Population Studied	Results	Theme(s) Related to the IVSR Program	Conclusions	MERSQI Score
Dalsing, 2012	How do VS trainees view their training experience?	Survey	IVSR and VSF current trainees and recent graduates; 2011	RR = 40% (28% of which were IVSR) Atmosphere, teaching faculty and PD were most important in ranking IVSR programs	Compare IVSR and VSF Recruitment Curriculum design	IVSR and VSF have similar educational needs with few differences noted.	6.0
Illig, 2012	Ensuring exposure of medical students to VS during medical school is most important step in recruitment	Survey	VS Program Directors (PD) and current IVSR and VSF trainees	RR = 33% PD's RR = 100% trainees (mandatory w/ VSITE) ~33% of IVSR and VSF's felt mandatory VS clerkship was most important recruitment tool	Recruitment Professional identity Politics	The VS community needs to provide exposure to the field and continued mentorship to effectively recruit medical students to the IVSR program.	6.0
Markovic, 2012	Does exposure to simulation increase medical student interest in VS?	Survey	Current medical students ($n = 80$)	Significant increase in interest in VS after exposure to simulation, but interest decreases with time from exposure	Recruitment	Single exposure of students to VS simulation increases interest but this does not last.	9.0
Zayed, 2012	Compare IVSR and VSF applicants	Retrospective review, single institution	IVSR and VSF ERAS applications to Stanford; NRMP data	IVSR applicants to Stanford have higher USMLE scores, more publications, post-graduate degrees, and top quartile of medical school class compared to VSF applicants	Compare IVSR and VSF Recruitment Workforce needs	IVSR applicants are "stronger" than VSF applicants.	5.5
Carroll, 2014	What is the impact of IVSR on operative case experience of VSF and GS trainees	Retrospective review of ACGME case logs	Single institution review of IVSR, VSF and GS ACGME operative logs	5% Decrease in cases done by GS over study period; 4% increase in primary cases by VSF; 15% drop in overall cases by VSF	Curriculum design Politics Uncertainty	The addition of the IVSR training program did not have a negative impact on the operative experience of VSF and GS trainees at a single institution.	5.5
Kiguchi, 2014	How does the surgical community view the IVSR training paradigm?	Survey	SVS members, Department of Surgery Chairs	RR = 26% 2/3 SVS members and $^1/_2$ of Dept Chairs believe IVSR grads prepared for practice; $^3/_4$ of Dept Chairs believe VSF is "better"	Workforce needs Compare IVSR and VSF Uncertainty	Overall perceptions of IVSR graduates are positive with some concern remaining regarding open surgical skills and maturity.	6.0

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TABLE 3 (*CONTINUED*)

Article	Hypothesis or Research Question	Research Methodology	Population Studied	Results	Theme(s) Related to the IVSR Program	Conclusions	MERSQI Score
Smith, 2014	Explore and describe the experiences of PD's in developing IVSR programs	Interviews; Qualitative	IVSR PD's	*N* = 26 (69% of PD's) 8 themes identified including hidden curriculum, local politics, and grand experiment	Curriculum design Politics Innovative program Uncertainty	Standardization of curricula could help current and future IVSR programs avoid common pitfalls in curriculum development.	6.5
Batista, 2015	To assess the initial operative experience of those graduating from IVSR vs those from VSF	Retrospective review of ACGME case logs	IVSR and VSF graduates from 2010-2013	VSF did more cases overall than IVSR; No difference in open vascular cases; IVSR did more basic endovascular cases; no difference in major endovascular cases	Compare IVSR & VSF Uncertainty	IVSR graduates have equivalent open vascular and overall superior endovascular operative experience compared to VSF graduates.	7.5
Colvard, 2015	What is the difference between IVSR and VSF grads in terms of job search, satisfaction with training and overall clinical exposure	Survey	IVSR and VSF graduates	RR = 69% IVSR and VSF with similar clinical experience in training; 100% of IVSR wanted academic job; VSF's received more interview offers; All were satisfied with their job	Trainee satisfaction Compare IVSR and VSF	Preliminary data suggests there is no difference between IVSR and VSF graduates on the parameters surveyed.	6.5
Dansey, 2015	To assess the structure of IVSR curriculum, resident perceptions of their program, and success of GS rotations	Survey	IVSR residents	RR = 31% IVSR residents are generally satisfied with faculty, non-VS rotations and relationship with GS	Curriculum design Trainee satisfaction Uncertainty	IVSR satisfaction with their training is generally high.	6.0
Macsata, 2016	"To compare the knowledge base and surgical skills of IVSR and VSF trainees using the milestones."	Survey	VS PD's	RR = 34% included evaluations of 24 IVSR and 63 VSF trainees; Times spent in GS significant strength of VSF; IVSR's lower on all milestones than VSF with main weakness open surgery	Compare IVSR and VSF Curriculum design Uncertainty	PD's of IVSR programs "should consider increasing time on GS and performing open surgical procedures."	6.0

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TABLE 3 (CONTINUED)

Article	Hypothesis or Research Question	Research Methodology	Population Studied	Results	Theme(s) Related to the IVSR Program	Conclusions	MERSQI Score
Peterson, 2016	To assess the opinions and impressions of community vascular surgeons regarding graduates of the IVSR program	Survey	Nonacademic vascular surgeons	RR = 17.5% 84% of those surveyed would interview an IVSR grad but just 72% would hire one	Compare IVSR and VSF Community perception Uncertainty	"Perceptions of VSF graduates as more mature and better prepared for open surgical cases may influence hiring patterns."	6.0
Smith, 2016	To describe the case volume and types of cases IVSR trainees complete during GS rotations	Retrospective review of ACGME operative logs	IVSR residents' ACGME operative logs	IVSR trainees do more open than laparoscopic GS cases, but primarily nonabdominal minor cases	Curriculum design	GS operative requirements, including case minimums, should be defined for IVSR programs.	6.5

Vascular Surgeons in the community, driving a perceived need to create more training programs. "Most projections have indicated a sharply increasing demand of at least 50% for vascular surgeons in the next 20 to 25 years, primarily due to the epidemiology of vascular disease."[1]

> "An objective of the SVS is to facilitate training of more vascular surgeons to meet the increasing demands for vascular care in the growing population of elderly patients. The 0-5 program allows students to . . .spend less time in training."
>
> (Johnston, 2008)

Finally, within the context of creating the 0+5 program, uncertainty regarding this new model was expressed.

> ". . .it is important that the vascular surgery programs keep tract of the careers of the graduates to determine the fate of individuals who have completed this program."
>
> (Flynn, 2006)

Process

After implementation of the 0+5 program, researchers began to investigate issues related to the process of the program, including success of the recruitment process, design and implementation of curricula, resident satisfaction with training, and comparisons of the 0+5 and 5 +2 programs and trainees. Throughout this body of literature there are expressions of uncertainty regarding the future of the training paradigm.

Evaluation of recruitment success was a prominent subtheme within this category. The popularity of the 0+5 program, including volume and quality of applicants, has been viewed as a marker of program success, noting that "the new [0+5] programs have been a huge success and show signs of reversing our recruiting fortunes," with "reports from the integrated programs. . .reflect[ing] a deep satisfaction with the quality of the applicants, many Alpha Omega Alpha (AOA) honorees, and most in the top quartile of their class."[24]

> "0+5 VS residency programs are providing the VS program directors new access to a highly qualified medical student applicant cohort."
>
> (Zayed, 2012)

The design and implementation of curricula within the 0+5 programs was frequently described as flexible, which was viewed as both an opportunity and a challenge.

TABLE 4. Summary of nonresearch articles.

Article	Type of Article	Theme(s) Related to the IVSR Program
Sicard, 2005	Presidential address	Politics Trainee satisfaction
Flynn, 2006	Opinion editorial	Recruitment Innovative program Uncertainty
Goldstone, 2006	Opinion editorial	Politics Trainee satisfaction Workforce needs
Keagy, 2006	Opinion editorial	Politics Recruitment Workforce needs Curriculum design
Stanley, 2006	Invited commentary	Politics Professional identity
Seeger, 2006	Opinion editorial	Politics Professional identity Innovative program
Berguer, 2007	Invited commentary	Politics Professional identity Recruitment Innovative program
Johnston, 2008	Presidential address	Workforce needs Politics Professional identity Innovative program
Mills, 2008	Historical summary	Compare IVSR and VSF Politics Workforce needs Curriculum design
Harthun, 2011	Opinion editorial	Politics Professional identity Innovative program
Makaroun, 2011	Presidential address	Politics Professional identity Workforce needs Recruitment Community perception
Mitchell, 2011	Opinion editorial	Politics Curriculum design Uncertainty
Dageforde, 2013	Opinion editorial	Workforce needs Recruitment
Eidt, 2012	Presidential address	Workforce needs Recruitment Professional identity Uncertainty

"[Program Directors felt] that flexibility to fit their program to the institution was beneficial."

(Smith, 2014)

"...the curriculum is going to change. I'm sure we didn't get it right."

(Smith, 2014)

Residents' opinions and satisfaction with their training in the 0+5 program was used as a surrogate marker for interim program success. Surveys of residents' attitudes were frequently utilized to answer questions related to how the program was going, without objective data of knowledge or skills reported in the literature. Residents in their first three years of the 0+5 training program

were found to be "pleased overall with the education provided by their programs."[10]

> "Most residents are satisfied with their education and the curriculum design of their programs. . .[and] findings from resident surveys such as this one should be considered in [ACGME guideline updates] to reflect resident opinion and feedback."
>
> (Dansey, 2015)

Within each of the subthemes in this category are examples of efforts to compare the 0+5 and 5+2 trainees.

> "both [integrated residency] and [independent fellowship] trainees are reaching acceptable milestones in knowledge base and surgical skills for graduation. However, . . .[integrated residency] trainees' milestones remain consistently lower than [independent fellowship] trainees' milestones."
>
> (Macsata, 2016)

Ongoing uncertainty regarding the 0+5 training model is expressed throughout the literature pertaining to the process of program implementation.

> "there is no evidence that the new training paradigms will provide superior or even equal training. In fact, the new training paradigms are being adopted largely based on promise without objective evidence of efficacy or efficiency."
>
> (Mitchell, 2011)

Outcomes

The first residents graduated from the 0+5 program in 2011, a much anticipated event for educational scholars who subsequently sought to understand the outcomes of the 0+5 training model. Subthemes within this category are similar to those within the "process" category, and include investigation of graduates' satisfaction with the program, comparisons of 0+5 and 5+2 graduates, and analysis of the perceptions practicing vascular surgeons hold regarding the 0+5 graduates. Once again, uncertainty was identified as a subtheme that permeated discussions related to the outcomes of the 0+5 training model.

Scholars turned to the 0+5 trainees themselves to understand the outcomes of the program.

> "Success of a new training paradigm still has to be in the eyes of those who chose to complete it. . .most of the 0+5 graduates expressed high satisfaction with their residency experience."
>
> (Covard, 2015)

It also appears that comparing the 0+5 program outcomes to the time-tested 5+2 program outcomes was an accepted method for evaluating the success of the 0+5 model.

> "Measured by operative experience and satisfaction with their training curriculum, there does not appear to be a significant difference between the 2 types of VS graduates."
>
> (Colvard, 2015)

In addition to comparisons of the two programs, the opinions of the Vascular Surgery community at large were considered in defining the outcomes of the 0+5 program.

> ". . .these programs have been developed largely a priori, without any preceding proof of concept. Furthermore, there remains some skepticism in the VS community about the surgical maturity of the 0+5 graduates and their preparedness for clinical practice."
>
> (Kiguchi, 2014)

Despite positive findings in several of these outcomes evaluations, expressions of uncertainty remained.

> "This paradigm shift has sparked a great deal of interest, but concern has been raised regarding the readiness of the 0+5 trainee to practice vascular surgery upon graduation."
>
> (Batista, 2015)

DISCUSSION

This scoping review of the literature pertaining to the development, implementation, and outcomes of the IVSR program is the first attempt to synthesize the existing knowledge on this topic. Qualitative analysis of the literature reveals issues related to the context of the program while under development, the processes of the program once implemented, and the outcomes of the program as graduates began to join the workforce. The body of evidence evaluating these issues is generally weak, with nearly half of available articles being opinion-based and research methodologies focused on attitudinal surveys with low response rates. There is a striking paucity of outcomes data for a program that now has 8 years of graduates in practice.

The aforementioned themes that emerged through this qualitative analysis are aligned with an existing conceptual framework that has been well described and extensively applied in educational program evaluation.

Stufflebeam's CIPP model of program evaluation includes the context, input, process, and product of a given program and is considered a decision-oriented approach to educational program evaluation.[38] Scholars who have contributed to the literature on the IVSR program have sought to evaluate the context, process, and product (or outcome) of this training model. Evaluation of the "input" element is generally lacking.

The literature pertaining to the context of program development was largely published in 2006 and primarily consists of opinion editorials and presidential addresses. There is little evaluation of the 5+2 program in the published literature to address whether or not this program was meeting the needs of the specialty and of trainees. The concern that the 5+2 program was becoming less desirable appears to be primarily related to trainee satisfaction and the ability to recruit trainees to the specialty. Based upon the opinions of medical students, it was believed that this trend was due to the prolonged training required and large incurred debt. Thus, the goal to decrease the length of training was a major driver of change. In hindsight, this perception may not have been accurate, given that the volume of applicants to the 5+2 program have subsequently rebounded and remained stable.[39] Furthermore, many IVSR programs require 2 additional years of research or academic development, resulting in a 7-year training program. These 7-year programs are among the most competitive and sought after 0+5 positions, suggesting that medical students may not be as sensitive to the time course of training as was previously theorized.

Input evaluation of a program serves structuring decisions, including what the program plans on doing and any feasible alternatives. A thorough evaluation of input factors helps to select the best strategy to meet contextual needs. There is little evidence of weighing alternatives to the IVSR model in the literature reviewed here. One article does mention the 4+2 and 3+3 training models as alternatives to consider, but quickly discards them as viable options stating that these models are "the same status quo we have had for decades... The plummeting statistics of recruitment of VS fellows in the last 5 years under these schemata reflect their shortcomings."[6] Other articles not included for review in this study espouse the strengths of the 4+2 training model with barely a sentence mentioning the IVSR model.[40,41] The political context that drove much of the IVSR program development may explain this dichotomy and lack of weighing of alternatives. The IVSR was the only option that enabled Vascular Surgery to have complete control over the training paradigm, making it the favored option to meet the contextual needs.

General Surgery had been engaged in discussion surrounding the need to restructure residency training, with suggestion to pursue an "early tracking" model in which residents would complete 3 years of general surgery and then move into subspecialty training.[42] The General Surgery community and leadership were not able to come to a consensus and did not move toward this new model in a comprehensive fashion. The vascular surgery community was hungry for change and did not wait for their general surgery colleagues to take the lead on a comprehensive overhaul of the structure of surgery residency training. Interestingly, this phenomenon may reflect an intense focus on inputs, or the weighing of alternatives, by the General Surgery community, which has slowed the pace and magnitude of changes implemented within the specialty.

It seems that vascular surgery leadership had a strong vision for the IVSR program to support the professional identity of the specialty, both as a symbol to the medical community of the unique expertise and skill set of vascular surgeons, as well as cultivating this identity internally for our trainees. While critical for the growth and sustainability of the specialty, this political emphasis may have lost sight of the importance of taking an educationally rigorous approach to the actual creation and implementation of the IVSR model, resulting in much of the uncertainty that was a common thread expressed throughout the context, process, and outcome themes across the literature.

As the IVSR model was adopted and implemented at institutions across the country, scholars sought to evaluate the processes of the programs in an effort to respond to the initial and ongoing uncertainty about this new approach to training vascular surgeons. The primary area of interest was evaluating the volume and quality of applicants to the IVSR programs. The strength of the applicants and extremely competitive nature of the programs was felt to indicate a demand for the IVSR program and was presented as a surrogate marker of "success" of the new paradigm. Given the previously described contextual issues of decreasing volume of applicants to the 5+2 programs and increasing workforce need for vascular surgeons, these were reasonable studies to undertake and suggest that the identified contextual needs for the 0+5 model were being met. Surveys of trainees to understand their satisfaction with the program was a second area of interest. The majority of trainees surveyed were in their first 3 years of the program and expressed positive early experiences. Finally, and perhaps most pervasive, is a frequent comparison of the 0+5 and 5+2 programs in terms of applicants, trainee satisfaction, operative numbers and milestone achievements. This constant effort to compare the 0+5 and 5+2 trainees is a reflection of a lack of competency-based assessment and competency-based matriculation and graduation requirements.

The uncertainty regarding the ultimate success of the IVSR paradigm will only be answered with rigorous evaluations of the outcomes of the program, particularly in terms of assessments of the graduates. Kirkpatrick's 4 level

evaluation model provides a framework to guide rigorous evaluation of program outcomes.[43] This model suggests that satisfaction of learners is the most basic and least rigorous form of program evaluation, followed by measures of learning, assessment of changes in the behavior of program graduates, and finally, evaluation of the program's results in the larger clinical context. As mentioned previously, just 3 articles have attempted to evaluate 0+5 program outcomes. Batista et al reviewed operative logs of graduates, which could be seen as a measure of learning if one accepts that case numbers are a surrogate for operative skill development and competence.[5] Colvard et al. analyzed trainee satisfaction with their training and job search, the first level on Kirkpatrick's pyramid.[8] Finally, Peterson et al. asked community vascular surgeons for their opinions regarding 0+5 program graduates.[27] While Peterson's work could be considered evaluation of the results of the program in the broader clinical context, it is important to note that this study surveyed community vascular surgeons who did not have exposure to 0+5 program graduates regarding their opinions of what graduates of this program might be like and whether or not they would consider hiring them. The response rate of just 17.5% makes it difficult to generalize their findings to the vascular surgery community writ large.

In his 2006 opinion editorial, Flynn wisely stated that "It is incumbent upon the profession to be sure that [the 0+5 program] improves the health care of the American public and provides for the needs of the young men and women who devote their lives to our specialty."[13] At the outset of the implementation of the 0+5 model, he called attention to the importance of critically evaluating the outcomes of the program. Twelve years later, we must look back at this statement and take it seriously. Now is the time to rigorously assess the outcomes of this model. The cat is now out of the proverbial bag, however. The 0+5 model has been adopted widely and closing the doors on this paradigm no longer appears to be an option. At this point we are left with the need to understand the strengths and weakness of this model and ensure that steps are taken to revise and build on what is already in place. If "the integrated program...is our ace in the hole," as Makaroun stated in his 2011 Eastern Vascular Society presidential address, then we must commit to identifying and embracing opportunities to improve the outcomes of this novel training model, for the benefit of current and future trainees and the patients they will ultimately care for.[24]

This study has several important limitations. First, just 57% of the articles included in the analysis were research studies, with the remainder being opinion pieces. The research studies were of low quality based on the MERSQI scoring system. Thus, there is a lack of rigorous evidence regarding the IVSR program available in the literature. Second, it is important to recognize that critical evaluation of the IVSR programs is documented through accrediting body documents (e.g., ACGME annual program review forms), which are not captured in a literature review and thus were not included in this study. Similarly, learner assessment of current residents and program graduates is conducted through the Vascular Surgery in Training Examination and Vascular Qualifying and Certifying Examinations of the American Board of Surgery respectively. The results of these formative and summative assessments have not been presented in the published literature, but are certainly available in other venues and provide important information regarding program outcomes. Finally, additional articles have been published since the original literature search was conducted for this review. Prior to dissemination of this review, on June 1st, 2018, we repeated a search of the current literature, identified and briefly reviewed the abstracts of 7 additional articles pertaining to the IVSR that were published after our original search. These abstracts appear to be generally consistent with the "process" theme and of comparable MERSQI quality to the articles reviewed herein.

CONCLUSIONS

In conclusion, the literature on the 0+5 integrated vascular surgery residency training model is of generally low research quality and reflects contextual, process, and outcome issues. Contextual issues were primarily addressed through opinion pieces, with the major drivers of the creation of the IVSR program being to improve recruitment to the specialty and address political issues of the time. Evaluation of process issues focused on the volume and quality of applicants and the satisfaction of trainees. There is a paucity of analyses of outcome issues. Further rigorous research is needed to understand the outcomes of the IVSR model to inform potential program modifications and to strengthen a paradigm that appears to be here to stay.

AUTHOR CONTRIBUTIONS

BKS: conception and design, data collection and analysis, manuscript preparation, critical revision. MD: data analysis, critical revision. IH: study design, data analysis, and critical revision. The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or nonfinancial interest (such as personal

or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this manuscript.

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SUPPLEMENTARY INFORMATION

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