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Challenges and satisfaction in Cardiothoracic Surgery Residency Programmes: insights from a Europe-wide survey

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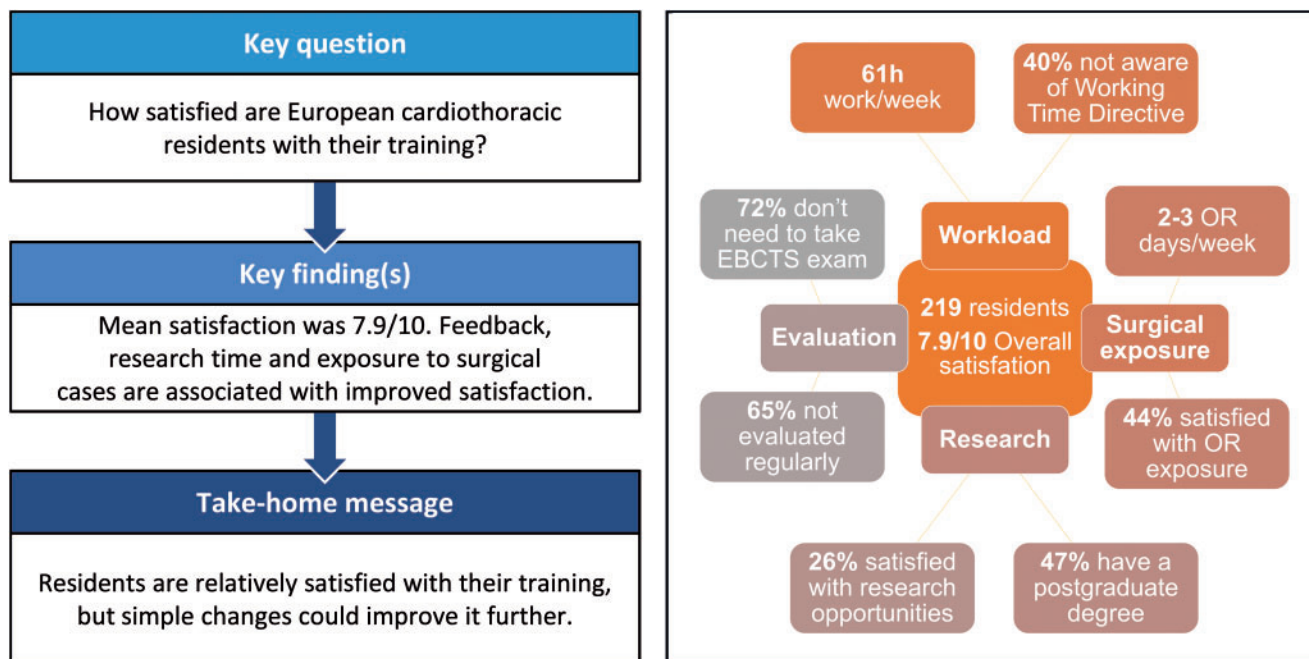
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Abstract

OBJECTIVES: The increasing complexity of surgical patients and working time constraints represent challenges for training. In this study, the European Association for Cardio-Thoracic Surgery Residents' Committee aimed to evaluate satisfaction with current training programmes across Europe.

METHODS: We conducted an online survey between October 2018 and April 2019, completed by a total of 219 participants from 24 countries.

RESULTS: The average respondent was in the fourth or fifth year of training, mostly on a cardiac surgery pathway. Most trainees follow a 5–6-year programme, with a compulsory final certification exam, but no regular skills evaluation. Only a minority are expected to take the examination by the European Board of Cardiothoracic Surgery. Participants work on average 61.0 ± 13.1 h per week, including 27.1 ± 20.2 on-call. In total, only 19.7% confirmed the implementation of the European Working Time Directive, with 42.0% being unaware that European regulations existed. Having designated time for research was reported by 13.0%, despite 47.0% having a postgraduate degree. On average, respondents rated their satisfaction 7.9 out of 10, although 56.2% of participants were not satisfied with their training opportunities. We found an association between trainee satisfaction and regular skills evaluation, first operator experience and protected research time.

CONCLUSIONS: On average, residents are satisfied with their training, despite significant disparities in the quality and structure of cardiothoracic surgery training across Europe. Areas for potential improvement include increasing structured feedback, research time integration and better working hours compliance. The development of European guidelines on training standards may support this.

Keywords: Cardio-thoracic surgery • Training • Survey • Working time directive

ABBREVIATIONS

CI	Confidence interval
EACTS	European Association for Cardio-Thoracic Surgery
EBCTS	European Board of Cardiothoracic Surgery
EWTD	European Working Time Directive
OR	Operating room
TMS	Training management system

INTRODUCTION

Over the past half century, cardiothoracic surgery has evolved from being a sub-speciality within the general surgery department to a distinct medical discipline [1]. However, numerous variants exist, as residents around the world can be trained as cardiac, cardiothoracic, cardiovascular or thoracic surgeons [2]. There is also wide variability in the structure of programmes, including lack of agreement in specified standards for certification.

In pursuit of a general European training system [3], the playing field was levelled by the introduction of the European Board of Cardiothoracic Surgery (EBCTS) examination for all European residents prior to acquiring official certification [4]. However, not all European countries have made this step mandatory: given regional differences in training, a general examination may not properly address country-specific required skills and knowledge.

In addition to the differences in residency programmes, the total number of cases operated on during training is shrinking due to several factors. Since its implementation in the early 2000s, the European Working Time Directive (EWTD) has limited the working hours for doctors in training. However, it remains debateable whether all countries adhere to these guidelines [5], and there is conflicting evidence on the impact of EWTD on surgical exposure [6–9]. Additionally, the increase in minimally invasive procedures, technically demanding complex cases [10, 11] and transcatheter alternatives for treatment of less complex coronary artery disease or isolated valve pathology may compromise learning opportunities [12].

In follow-up to the 2010 report by the Surgical Training and Manpower Committee of the European Association for Cardio-Thoracic Surgery (EACTS) [5], a Europe-wide survey was conducted by the EACTS Residents Committee to evaluate the changes and differences in training programmes, resident satisfaction, EWTD adherence and EBCTS exam implementation across different countries.

MATERIALS AND METHODS

An online, computer-assisted and voluntary anonymous questionnaire (Survey Monkey, SurveyMonkey Enterprise, Los Angeles, CA, USA) was launched in October 2018 during the EACTS Annual Meeting in Milan, Italy. Weblinks were included in residents-specific EACTS newsletters on 2 occasions and also distributed via national residents' organizations and personal communication. The survey was accessible until April 2019. The questionnaire was designed specifically for the purpose of this survey and based on the previously published report [5]. It comprised 3 sections (demographics, training and evaluation) and 25 questions (Table 1). Respondents scored their satisfaction with surgical exposure and research time using nominal ordinal five-point scale questions (very dissatisfied, dissatisfied, neutral, satisfied or very satisfied), and overall satisfaction using a numeric scale (1–10).

Statistical analysis was performed using Stata/IC 14.2 statistical package (StataCorp LLC, College Station, TX, USA). Mean \pm standard deviation or median and interquartile range and valid percentages described continuous and categorical variables, respectively. To evaluate potential associations between prespecified independent variables [year of training; regular skills evaluation; protected time for research; weekly operating room (OR) sessions (in total, performed as first operator or assistant), weekly working hours (in total, dedicated to administrative work or spent on call)] and overall satisfaction, we used linear mixed-effects models assuming nesting within countries. For each variable, a model was run with it and the random intercept for country was included as predictors, and satisfaction as the outcome.

Table 1: Questions included in the survey by category

Demographics	Training	Evaluation	
Age	How many hours do you work on an average week?	Do you use a training management system (TMS)?	Is there a regular evaluation of your skills?
Gender	How many operating room sessions (half day) do you attend on an average week?	How many years of training after Med School are required until you are certified as a specialist?	How many major surgical procedures required for certification?
Country where you are doing residency	How many cases do you assist per week?	Do you have protected time for research?	Do you have to take a final exam (excluding the European Board Exam) for certification?
Are you an EACTS member?	How many cases do you operate as principal operator per week?	Are you satisfied with the research opportunities of your programme?	Are you expected by your institution to take the European Board Exam?
Which year of training are you in?	Are you satisfied with the operative exposure of your programme?	How satisfied are you with the quality of your training?	
Predicted calendar year for finishing your training?	How many hours are you on call per week?	Are you aware of the existence of a National Residents association in your country?	
Speciality: cardiac, thoracic, cardio-thoracic, cardio-vascular	How much time do you spend on administration? (hours a week)		
Do you have a post-graduate degree?	Is European Working Time Directive (EWTD) implemented in your centre?		

The same approach was used to measure the association between year of training and each job characteristic. Associations were considered statistically significant if the 95% confidence interval (CI) did not contain 0.

A total of 219 participants from 24 different European countries completed the questionnaire. For 7 countries, there were ≥ 10 respondents.

RESULTS

Demographics

Of the 219 residents completing the survey, 74 (34.3%) were female and the mean age of the total sample was 31 (with ± 3.9 SD) years. Although the survey was answered by residents from years 1 to 6 (Table 2), the average participant was in the fourth or fifth year of training. Most participants were in cardiac surgery training (54.3%), with a minority in training for thoracic, cardiovascular or cardio-thoracic surgery (Table 2). Despite 47.0% having a postgraduate degree (Table 2), only 13.0% reported having designated research time integrated in the training programme. Only 2 residents (1.0%) declared lack of interest in research. Of the respondents, 42.0% were EACTS members and 8.7% were applicants. Interestingly, 43.0% were aware of an active National Residents Association, while 20.7% claimed that despite the existence of one, it was not very active. Table 2 illustrates the participants' demographics.

Training programme details

Most training programmes have a pre-defined length of 5–6 years (72.3%), but with no regular skills evaluation (64.9%) (Table 3). The use of any training management system (TMS) was absent for 75.9% of respondents. Regarding the number of required cases during residency, 59.1% of respondents stated that 75–150 operations were needed to be qualified as a specialist.

Notably, in 15.9% of the cases the requirement number was < 75 cases, and in another 14.6%, < 10 . Passing a final exam was imperative for certification in 75.9% of answers, although 72.1% reported that EBCTS examination was not officially recommended or expected by the institution.

Working hours and operating room exposure

Survey participants reported working 61.0 ± 13.1 h on an average week, of those 27.1 ± 20.2 and 13.7 ± 12.0 are spent on call and on administrative tasks, respectively. No evidence was found for an association between training year and the total weekly working hours ($\beta = 0.78$; CI -0.14 to 1.70) or hours spent on call ($\beta = 1.05$; CI -0.42 to 2.53) or on administrative work ($\beta = -0.26$; CI -1.12 to 0.62). Interestingly, only 19.7% of residents confirmed the implementation of the EWTD and 42.0% were unaware of the specific European regulations on working hours. On average, residents reported participating in 5.4 ± 2.9 OR sessions per week, in 4.1 ± 3.0 of which as assistant (Fig. 1). The median reported monthly cases as primary surgeons was 1 (interquartile range 0–4). Training year was associated with total number of OR sessions per week ($\beta = 0.33$; CI 0.13–0.53), and the percentage of cases performed as first operator ($\beta = 0.09$; CI 0.02–0.17). We found no statistically significant association between training year and the ratio of cases performed as assistant to total ($\beta = 0.02$; CI -0.01 to 0.06).

Satisfaction

Of all respondents, 43.8% were at least satisfied with the amount of OR exposure in their training, and 37.6% were dissatisfied or very dissatisfied (Fig. 2). Only 26.0% considered research opportunities satisfactory or very satisfactory (Fig. 2). The overall satisfaction with an individual's training programme was 7.9 ± 1.3 out of 10. Regular skills evaluation ($\beta = 1.16$; CI 0.81–1.50), total number of weekly OR sessions ($\beta = 0.12$; CI 0.04–0.20), percentage of cases performed as first operator ($\beta = 0.60$; CI 0.20–1.00) and

Table 2: Demographics and overall characteristics of surveyed residents

N	219						
Age (years)	31 (3.9)						
Female gender	74 (34)						
Country	De	Fr	Pt	It	Ch	Bg	
	55 (25)	31 (14)	19 (8.8)	14 (6.5)	12 (5.6)	10 (4.7)	
	Se	Dk	Fi	Gb	At	Nl	
	10 (4.7)	7 (3.3)	7 (3.3)	7 (3.3)	6 (2.8)	6 (2.8)	
	Gr	Ru	Es	Hr	Ee	Tr	
	5 (2.3)	4 (1.9)	4 (1.9)	3 (1.4)	3 (1.4)	3 (1.4)	
	Ua	By	Cz	Hu	Lv	Rs	
	3 (1.4)	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)	
Training year	1	2	3	4	5	6	> 6
	18 (8.4)	31 (14)	31 (14)	43 (20)	37 (17)	29 (14)	26 (12)
Speciality	Cardiac	Thoracic	CT	CV	CTV		
	119 (54)	22 (10)	45 (21)	19 (8.7)	14 (6.4)		
Postgraduate degree	No	MSc	PhD				
	116 (53)	43 (20)	60 (27)				
EACTS membership	No	Applicant	Yes				
	108 (49)	19 (9)	92 (42)				
Residents' association	No	Not active	Yes				
	70 (36.3)	40 (20.7)	83 (43.0)				

Data are displayed as *n* (%) or mean (standard deviation), unless otherwise specified.

AT: Austria; BG: Bulgaria; BY: Belarus; CH: Switzerland; CT: Cardiothoracic; CTV: Cardiothoracic and Vascular; CV: Cardiovascular; CZ: Czech Republic; DE: Germany; DK: Denmark; EACTS: European Association for Cardiothoracic Surgery; EE: Estonia; ES: Spain; FI: Finland; FR: France; GB: UK; GR: Greece; HR: Croatia; HU: Hungary; IT: Italy; LV: Latvia; MSc: Master of Science; NL: Netherlands; PhD: Doctor of Philosophy; PT: Portugal; RS: Serbia; RU: Russia; SE: Sweden; TR: Turkey; UA: Ukraine.

Table 3: Training programme details

N	219			
Regular skills evaluation	No	Yes		
	124 (65)	67 (35)		
Training management system	No	Yes, EACTS	Yes, other	
	145 (76)	15 (7.9)	31 (16)	
Final certification exam	No	Yes		
	46 (24)	145 (76)		
EBCTS examination	Not aware	No	Yes	
	29 (15)	137 (72)	24 (13)	
Years for certification	<5	5–6	>6	
	26 (14)	138 (72)	27 (14)	
Procedures for certification	<10	10–75	75–150	>150
	24 (15)	26 (16)	97 (59)	17 (10)

Data are displayed as *n* (%) unless otherwise specified.

EACTS: European Association for Cardio-Thoracic Surgery; EBCTS: European Board of Cardiothoracic Surgery; N: number.

having protected time for research ($\beta = 0.5$; CI 0.01–1.03) were associated with higher overall satisfaction. The reported number of weekly hours dedicated to administrative work was negatively associated with overall satisfaction ($\beta = -0.04$; CI -0.05 to -0.02). No statistically significant association was found between overall satisfaction and weekly number of OR sessions performed as assistant operator ($\beta = 0.02$; CI -0.05 to 0.09), total number of working hours ($\beta = 0.002$; CI -0.01 to 0.02) or amount of time on call ($\beta = 0.001$; CI -0.01 to 0.01).

DISCUSSION

European cardiothoracic surgery training programmes are facing a substantial challenge due to increasing complexity of

referred patients and decreased surgical exposure. We performed a Europe-wide survey amongst residents to get an update on common challenges in training programmes across the continent. While the previous survey from 2010 focused mainly on working hours and the results after implementation of the EWTD, the current EACTS Residents' Committee aimed to evaluate (i) the residents' satisfaction, (ii) the heterogeneity among training programmes and (iii) the role of EBCTS examination and the use of a structured TMS across Europe a decade later [5].

One-third of the participating trainees were female, similar to that reported in a recent Canadian survey [13]. In a large US survey, only 3.4% of adult cardiac, 5.2% of congenital heart and 7.9% of general thoracic surgeons were female [14]. Although there is a foreseeable and welcomed increase in the number of

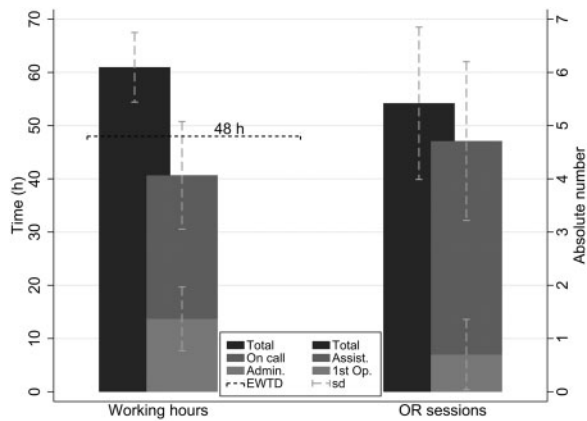


Figure 1: Working week details. Left-hand side panel summarizes average work distribution per week. Right-hand side panel OR work details. Admin.: administrative work; Assist.: participation in surgeries as assistant; EWDT: European Working Time Directive; N: number; OR: operating room; SD: standard deviation; 1st op.: participation in surgeries as first operator*. *For illustration purposes, the number of OR sessions as first operator per week was calculated by dividing the monthly reported number by 4.

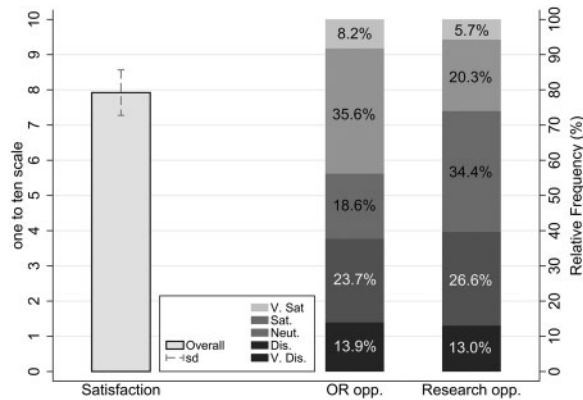


Figure 2: Satisfaction among surveyed residents. Left-hand side column shows overall satisfaction expressed on a scale of 1–10. Right-hand side columns depict stacked relative frequencies of satisfaction ranks on a five-point scale for OR exposure and research designated time. Dis.: dissatisfied; Neut.: neutral; opp.: opportunity; OR: operating room; SD: standard deviation; Sat.: satisfied; V.: very.

female cardiothoracic surgeons, true gender equity is still not a reality, and unlikely to be so for quite some time [15, 16].

We distinguished between the different specialities, as several combinations exist across Europe: from separate training in cardiac and thoracic surgery, to combined departments, and the additional involvement of vascular surgery. Most trainees in the sample are specifically trained in cardiac surgery (54.3%) in comparison to cardiothoracic (20.5%), thoracic (10.0%) or cardiovascular programmes (8.7%). As described earlier in the US training survey, over the last decade, speciality interests have changed, with decreasing interest in mixed cardiac/thoracic surgery, and a tendency to focus on adult cardiac surgery or thoracic surgery [2]. Concrete steps towards the implementation of a European curriculum for thoracic surgery as a mono-speciality have been published recently in a position paper by the European Society of Thoracic Surgeons [17]. This phenomenon might be explained by the emergence of sub-specialization, with its additional required training time. With increasing complexity of surgical and interventional techniques, it has become more challenging to

master all techniques in cardiac, vascular and thoracic surgery. However, in an interesting recent report, Antonoff *et al.* [18] found an association between sub-specialization and self-reported lack of preparedness, which underscores one of the possible drawbacks of premature sub-specialization in one's training.

In most countries, trainees are required to perform a specific number of cases for national certification, whereas 10 years ago, fewer trainees required a specific case number. Some national societies reacted proactively towards the trend of increasing transcatheter therapies with a reduction in the required number of open cases, and introduction of interventional skills into training programmes [11]. The majority of the survey participants (59%) need between 75 and 150 cases for their speciality certificate, which is still a wide range. Only 10% require more than 150 operations while 31% stay below 75 cases. However, as evident from resident feedback during our study, the definition of an operation performed by a trainee may also differ from one country to another: for some, it can be defined by performing the most important steps of the operation and for others, performing everything skin to skin. In addition, the number of minimally invasive procedures required may differ. These were not specified in our survey. Thus, the quality and ability of a fully trained European surgeon becomes difficult to assess by only the national certificate. A standardized practical training guide with clear definitions and numbers of operations including minimally invasive approaches could contribute to a higher quality of surgical performance.

Given the trend for sub-specialization and the reduction in OR time trainees face, an alternative approach to case number-driven accreditation could be an objective assessment of competencies. This individualized approach facilitates a more accurate competency-based assessment using the framework of Entrustable Professional Activities. Entrustable Professional Activities describe key tasks of a speciality that a trainee can be trusted to perform. The concept was developed in the early 2000s in the Netherlands and is gradually being introduced in several undergraduate medical education systems in the USA and Canada and surgical residency programmes in various European countries [19]. Additionally, regular evaluation of overall physician professionalism is becoming more important [20]. Within cardiothoracic surgery, non-technical skills should be particularly emphasized.

While 75.9% of residents must sit a final exam, only 12.6% are expected to pass the standardized EBCTS certification. A standardized American Board of Thoracic Surgery exam poses a clear final step before becoming an independent surgeon [21], whereas a pan-European exam (EBCTS) is still lacking universal recognition. Moreover, our survey demonstrated that 75.9% of participants do not use any TMS at all. This raises an important question: how is medical education documented, and how can standards of high-quality training be maintained in such programmes? Since 2018, EACTS has made a digital portfolio/TMS (EACTS TMS) available, which is freely available to EACTS members. The EBCTS has transitioned to a 2-level, high-standard and reproducible examination. Expert educationalists are involved in exam development and assessment, and Quality Assurance auditing is an integral part of them. The level 1 examination, comprising 180 multiple choice questions, is designed as a training exit examination for cardiac, thoracic or cardiothoracic surgery trainees, and several countries have adopted it as such (Switzerland, Netherlands). Both the EACTS TMS and the EBCTS exam are new resources which could make education in cardiothoracic surgery more transparent and comparable across borders. In the current

era of progressive globalization, surgeons who are considering moving to different European countries might benefit from a standardized and integrated documentation system, for both training and definitive settlement.

In our sample, spending more working hours in the OR and more time as the primary surgeon contributes significantly to the satisfaction of the trainees. Interestingly, increased administrative work correlated with dissatisfaction. Mean working hours per week were 60 (± 13). Of all respondents, 38% claimed that the EWTD was not implemented in their centre, and 42% were not even aware of its existence. Ten years after the first debate about its influence on training, there seem to be no relevant changes related to the EWTD [5]: trainees are working the same hours and seem to do so regardless of any regulation. Still, we feel it is imperative to adapt and adhere to these directives which are enshrined in law. Although solid data are still lacking in the literature, we speculate that with the use of individualized approaches, competency-focused training and innovative training programme designs, working hours could be limited without a compromise in surgical proficiency [22]. Other forms of hands-on education should be investigated and implemented, e.g. simulation-based training, especially with regard to minimally invasive and transcatheter procedures [23]. Moreover, the importance of a good work-life balance and its impact on the incidence of burnout and surgical outcomes are supported by a growing evidence base [24, 25].

Almost half of the trainees (47%) have some form of a post-graduate degree, although there is a wide variety in duration, structure and intensity of such research programmes across different countries [26]. Unfortunately, during training, research opportunities become increasingly rare and 40% of the respondents are either dissatisfied or very dissatisfied with their research opportunities. Only 13% have protected time integrated in the training programme to perform research activities. Although the involvement in scientific projects is often encouraged and crucial for further career development, it remains challenging to combine a successful clinical and scientific career during training. Our survey underscores an opportunity to avoid wasted expertise. Physician-scientists have always been critical innovators in medicine, including many of the Nobel Prize laureates in Physiology or Medicine. There is a profound need to integrate academic pathways into cardiothoracic surgery training, as practised, for example, by some centres in USA [27]. Not only the increase of scientific work in our speciality but also the ability to interpret results distinguish between low- and high- quality research and transport findings into daily practice are few reasons for the necessity to reserve protected time for theoretical education. [28].

This survey might suggest a slight improvement, as the overall mean satisfaction was 7.9 out of 10. However, the operative exposure seems to be very heterogenous with 37.6% being very dissatisfied to dissatisfied, 18.6% neutral and 43.8% satisfied to very satisfied. This issue was not addressed in the previous survey. Our study revealed that trainees who receive a regular evaluation of their work are significantly more satisfied. This underlines the importance of structured feedback and lines up with the reports from well-structured training programmes [28, 29].

Limitations

The questionnaire was in English, which is not the native language of most respondents. This may have affected responses,

especially where subjective assessment was required. Although the current questionnaire generated more actual responses than prior surveys, it remains unclear what the relative response rate is, as the sample frame size is unknown. Based on resident numbers available via personal communication from national resident associations, the response rate could be estimated to vary between 7% (UK, 100 residents) and 68% (Portugal, 28 residents) per country. Subsequently, this survey may have been affected by sampling biases. Furthermore, we do not possess follow-up data on participants and can therefore not relate our current findings to long-term outcomes such as job-finding and surgical performance.

This questionnaire was sent to residents only, to understand perceived residents satisfaction. Thus, data on training programme details are based only on information from residents; to obtain data on official curriculum and programme structure, contacting also heads of training would be important and should be addressed in future studies. Certainly, education is not a one-way road: a certified teacher as an additional parameter for quality has not been covered by our survey, but will hopefully in future, as education itself evolves as an academic discipline in our field [30].

Overall satisfaction in education is a subjective parameter which does not depend only on established training pathways and standardized curricula but also on individual motivations and ambitions. However, giving trainees the chance to anonymously score specific fields like OR and research exposure gives an idea where the most attention is needed to prepare European cardiothoracic units for the future.

CONCLUSION

Most European trainees are satisfied with their training, but there appear to be significant disparities in the quality and structure of cardiothoracic surgery training programmes. Issues to be improved include documentation, professional feedback, poor implementation of research dedicated time and increasing administrative work. Interestingly, overall working hours seem to play a minor role regarding the satisfaction of the residents. A compulsory introduction of a standardized European accreditation exam (e.g. EBCTS) and standardized training documentation (using a TMS) might be key tools to provide uniform, high-quality education throughout Europe. In addition, the development of European guidelines for training with measurable criteria may support the improvement of training systems.

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Author contributions

Rui J. Cerqueira: Conceptualization; Data curation; Formal Analysis; Investigation; Methodology; Project administration; Resources; Validation; Visualization; Writing—original draft; Writing—review & editing. **Samuel Heuts:** Conceptualization; Investigation; Methodology; Validation; Writing—

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Reviewer information

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REFERENCES

- [1] Tchantchaleishvili V, LaPar DJ, Stephens EH, Berfield KS, Odell DD, DeNino WF. Current integrated cardiothoracic surgery residents: a Thoracic Surgery Residents Association survey. *Ann Thorac Surg* 2015; 99:1040–7.
- [2] Stephens EH, Odell D, Stein W, LaPar DJ, DeNino WF, Aftab M *et al.* A decade of change: training and career paths of Cardiothoracic Surgery Residents 2003 to 2014. *Ann Thorac Surg* 2015;100:1305–13; discussion 13.
- [3] Loubani M, Sadaba JR, Myers PO, Cartwright N, Siepe M, Emmert MY *et al.* A European training system in cardiothoracic surgery: is it time? *Eur J Cardiothorac Surg* 2013;43:352–7.
- [4] Depypere LP, Lerut AE. Thoracic surgical training in Europe: what has changed recently? *Ann Transl Med* 2016;4:89.
- [5] Sadaba JR, Loubani M, Salzberg SP, Myers PO, Siepe M, Nia PS *et al.* Real life cardio-thoracic surgery training in Europe: facing the facts. *Interact CardioVasc Thorac Surg* 2010;11:243–6.
- [6] Sadaba JR, Urso S. Does the introduction of duty-hour restriction in the United States negatively affect the operative volume of surgical trainees? *Interact CardioVasc Thorac Surg* 2011;13:316–19.
- [7] Lim E, Tsui S; on behalf of the Registrars and Consultant Cardiac Surgeons of Papworth Hospital. Impact of the European Working Time Directive on exposure to operative cardiac surgical training. *Eur J Cardiothorac Surg* 2006;30:574–7.
- [8] Mahesh B, Sharples L, Codispoti M. Effect of the full implementation of the European Working Time Directive on operative training in adult cardiac surgery. *J Surg Educ* 2014;71:492–9.
- [9] West D, Codispoti M, Graham T; Specialty Advisory Board in Cardiothoracic Surgery of the Royal College of Surgeons of Edinburgh. The European Working Time Directive and training in cardiothoracic surgery in the United Kingdom. *Surgeon* 2007;5:81–5; quiz 85, 121.
- [10] Vohra HA, Ahmed EM, Meyer A, Kempfert J. Knowledge transfer and quality control in minimally invasive aortic valve replacement. *Eur J Cardiothorac Surg* 2018;53:ii9–13.
- [11] Wick A, Beckmann A, Nemeth A, Conradi L, Schafer A, Reichenspurner H *et al.* Cardiac surgery residents training in Germany—Status quo and future prospects. *J Thorac Cardiovasc Surg* 2020;159:579–87.
- [12] Ailawadi G, Kron IL. The challenges facing cardiothoracic surgeons. *Vasc Dis Manag* 2007;4.
- [13] Mewhort HE, Quantz MA, Hassan A, Rubens FD, Pozeg ZI, Perrault LP *et al.* Trainee perceptions of the Canadian cardiac surgery workforce: a survey of Canadian cardiac surgery trainees. *Can J Cardiol* 2017;33:535–39.
- [14] Shemin RJ, Ikonomidis JS. Thoracic surgery workforce: report of STS/AATS Thoracic Surgery Practice and Access Task Force—snapshot 2010. *J Thorac Cardiovasc Surg* 2012;143:39–46, 46.e1–6.
- [15] Antonoff MB, David EA, Donington JS, Colson YL, Litle VR, Lawton JS *et al.* Women in thoracic surgery: 30 years of history. *Ann Thorac Surg* 2016;101:399–409.
- [16] Donington JS, Litle VR, Sesti J, Colson YL. The WTS report on the current status of women in cardiothoracic surgery. *Ann Thorac Surg* 2012;94: 452–8; discussion 58–9.
- [17] Massard G, Tabin N, Mitchell S, Batirel H, Brunelli A, Elia S *et al.* A harmonized European training syllabus for thoracic surgery: report from the ESTS-ERS task force. *Eur J Cardiothorac Surg* 2018;54:214–20.
- [18] Antonoff MB, Luc JGY, Patterson GA, Meyers BF, Damiano RJ Jr, Moon MR. Graduate subspecialty and perceptions of cardiothoracic surgery training: a 60-year retrospective study. *Ann Thorac Surg* 2019;107: 285–93.
- [19] Brasel KJ, Klingensmith ME, Englander R, Grambau M, Buyske J, Sarosi G *et al.* Entrustable professional activities in general surgery: development and implementation. *J Surg Educ* 2019;76:1174–86.
- [20] Li H, Ding N, Zhang Y, Liu Y, Wen D. Assessing medical professionalism: a systematic review of instruments and their measurement properties. *PLoS One* 2017;12:e0177321.
- [21] Rusch VW, Calhoun JH, Allen MS, Baumgartner W. The American Board of Thoracic Surgery: update. *Ann Thorac Surg* 2012;93:363–5.
- [22] Sádaba JR, O'Regan DJ, Kappetein AP. Adapt or die the imperative for a culture of innovation in cardio-thoracic surgical training. *Eur J Cardiothorac Surg* 2007;31:959; author reply 60.
- [23] Sardari Nia P, Heuts S, Daemen JHT, Olsthoorn JR, Chitwood WR, Maessen JG. The EACTS simulation-based training course for endoscopic mitral valve repair: an air-pilot training concept in action. *Interact CardioVasc Thorac Surg* 2020;30:691–98.
- [24] Dimou FM, Eckelbarger D, Riall TS. Surgeon burnout: a systematic review. *J Am Coll Surg* 2016;222:1230–39.
- [25] Jarral OA, Baig K, Shetty K, Athanasiou T. Sleep deprivation leads to burnout and cardiothoracic surgeons have to deal with its consequences. *Int J Cardiol* 2015;179:70–2.
- [26] Kehm BM. Quo vadis doctoral education? New European approaches in the context of global changes. *Eur J Educ* 2007;42:307–19.
- [27] Permar SR, Ward RA, Barrett KJ, Freel SA, Gbadegesin RA, Kontos CD *et al.* Addressing the physician-scientist pipeline: strategies to integrate research into clinical training programs. *J Clin Invest* 2020;130:1058–61.
- [28] Lebastchi AH, Yuh DD. Nationwide survey of US integrated 6-year cardiothoracic surgical residents. *J Thorac Cardiovasc Surg* 2014;148:401–7.
- [29] Chan J, Oo S, Yeatman M. Is there a national variation in cardiothoracic trainees' satisfaction? Evaluation of the United Kingdom General Medical Council national training surveys. *J Card Surg* 2019;34:1069–74.
- [30] Verrier ED. The surgeon as educator. *Thorac Surg Clin* 2019;29:227–32.