Optimising workplace learning in postgraduate medical education

Towards supporting residents and supervisors in clinical practice

Marieke Robbrecht

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Optimising Workplace Learning in Postgraduate Medical Education

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Promotors:

Prof. dr. Steven Weyers
Visiting Prof. dr. Mieke Embo
Prof. dr. Antonius Mulder

Advisory committee:

Prof. dr. Martin Valcke
Prof. dr. Myriam Van Winckel

An interdisciplinary, joint PhD

Ghent University
Faculty of Medicine and Health Sciences
Faculty of Psychology and Educational Sciences

University of Antwerp
Faculty of Medicine and Health Sciences

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Promotors

Prof. Dr. Steven Weyers	Professor at the Faculty of Medicine and Health Sciences, Ghent University
Visiting Prof. Dr. Mieke Embo	Visiting professor at the Faculty of Medicine and Health Sciences, Antwerp University Post-doctoral researcher at the Department of Educational Sciences, Ghent University Post-doctoral researcher at the Expertise Network Health and Care, Artevelde University of Applied Sciences in Belgium
Prof. Dr. Twan Mulder	Professor at the Faculty of Medicine and Health Sciences, University of Antwerp

Scientific committee

Prof. Dr. Martin Valcke	Professor emeritus at the Faculty of Psychology and Educational Sciences, Ghent University
Prof. Dr. Myriam Van Winckel	Professor emeritus at the Faculty of Medicine and Health Sciences, Ghent University

Doctoral committee

Prof. Dr. Daniël De Wolf	Professor at the Faculty of Medicine and Health Sciences, Ghent University
Prof. Dr. Lien Dossche	Professor at the Faculty of Medicine and Health Sciences, Ghent University
Prof. Dr. Anneliese Moerman	Professor at the Faculty of Medicine and Health Sciences, Ghent University
Prof. Dr. Bram De Wever	Professor at the Faculty of Psychology and Educational Sciences, Ghent University
Prof. Dr. Danny Mathysen	Professor at the Faculty of Medicine and Health Sciences, Antwerp University
Prof. Dr. Katrien Bombeke	Professor at the Faculty of Medicine and Health Sciences, University of Antwerp
Prof. Dr. Paul Brand	Professor at the Faculty of Medical Sciences, University of Groningen

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List of abbreviations

ACGME	Accreditation Council for Graduate Medical Education
ANIOS	Resident not in training ('Arts Niet In Opleiding tot Specialist')
CanMEDS	Canadian Medical Education Directives for Specialists
CAF	Communication assessment and feedback
CALM	Concise assessment of leader management
CBME	Competency-based medical education
CELI	Control, Explaining, Listening, Influencing
CI	Confidence interval
CLE	Clinical learning environment
EAP	European Academy of Paediatrics
ELT	Experiential learning theory
EM	Emergency medicine
EPA	Entrustable professional activities
ePortfolio	Electronic portfolio
ECTS	European credit transfer system
F	Female
GDPR	General Data Protection Regulation
GHQ	General health questionnaire
GPs	General practitioners
IQR	Interquartile range
M	Male
MCTQ	Maastricht Clinical Teaching Questionnaire
MERSQI	Medical Education Research Quality Instrument
MSG	Master Specialistische Geneeskunde
MSM	Master of Specialistic Medicine
N/A	Not applicable
NICU	Neonatal intensive care unit
NLS	Neonatal life support
NVR	No video review

PBA	Procedure Based Assessment Forms
PGME	Postgraduate medical education
PGY	Postgraduate year
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
RCT	Randomised controlled trial
RQ	Research question
SETQ	System for Evaluation of Teaching Qualities
SBO	Strategic Basic Research ('Strategisch Basisonderzoek')
SP	Strengths ('sterke punten')
ST	Specialty trainee
SWOT	Strengths, weaknesses, opportunities, threats
THM	Take home messages
UEMS	European Union of Medical Specialists
UGME	Undergraduate medical education
UK	United Kingdom
USA	United States of America
VASO	Flemish Association for Medical Specialists in Training ('Vlaamse Vereniging voor Arts-Specialisten in Opleiding')
Video-CAF	Video communication assessment and feedback
VR	Video review
VRE	Video reflexive ethnography
WP	Challenges ('werkpunten')
WPL	Workplace learning
XTR	Extra

Chapter 1:
General introduction

"I hear and I forget. I see and I remember. I do and I understand."

Confucius

0. INTRODUCTION

Postgraduate medical education (PGME) and workplace learning (WPL) are complex concepts with a long, intricate history. This introduction is dived into two parts to provide a comprehensive understanding of the key issues addressed in this thesis. The first part traces the evolution of PGME and WPL over time in Flanders, offering necessary context to understand the broader challenges these concepts face today. The second part focuses on theoretical frameworks related to WPL in PGME. As no single theory encompasses all relevant challenges, the introduction highlights those theories that are most pertinent to the issues explored in this thesis. Specifically, the focus will be on three key areas where theory and challenges intersect: the workplace (the clinical setting where residents spend the majority of their time), the outcomes (the learning goals residents must achieve before graduation), and the learning processes that occur during residency. Together, this information provides essential background for understanding the studies presented in this thesis.

1. A SHORT HISTORY OF MEDICAL EDUCATION

Postgraduate medical education (PGME) consists mainly of workplace learning (WPL), which is learning the profession while doing it in authentic healthcare practice. Both medical education and WPL have seen many evolutions in the last centuries. For a long time, there was an enormous difference between surgeons and physicians. Physicians followed a more theory-based formal educational program at universities. It was the basis for medical education, currently known as undergraduate medical education (UGME).[1] Surgeons were mainly educated through an apprenticeship model, by observing and participating in clinical practice under the guidance of an experienced professional.[2] This meant that the profession was mainly taught in practice, often with little theoretical underpinnings.[3] Medical knowledge expanded significantly during the 17th century, leading to a rise in scientifically supported surgical practices.[3] Over time, surgeons began to undergo similar basic medical training as physicians. However, practical experience in the profession remained exclusive to post-graduation settings.

In the early 1900s in Europe, coinciding with Flexner's report in the United States of America, it became evident that relying solely on textbook learning during UGME was inadequate for educating competent physicians.[4,5] There was a need for strong premedical preparation,

which meant that medical students were exposed to clinical experiences before graduating, a practice known as clerkships.[6] Recognising the need for accountability and regulation to provide effective medical care for the public, WPL became integrated into the curriculum of UGME.[7-9]

However, the limited clinical exposure during clerkships in UGME proved insufficient to practice specialised medicine. Some attribute the establishment of further specialised training, called residency, to William Osler.[4] The term 'residency' originated from the necessity for specialists in training to practically live in and for the hospital. Residents engaged in WPL as they were learning while working, with a balanced effort between clinical practice and scientific research.[10] This research was facilitated by patients' extended hospital stays, often several weeks or even months, which provided residents with ample opportunities to delve into medical insights and to deeply understand their patients. Residency, lasting several years, often occurred outside of university affiliations and was primarily based on apprenticeship principles. There was little investigation into how residents learned, and there was no explicit link between theory and practice. Although the better institutions involved good professional and personal relationships within the hospital, there were already instances of exploitation of residents.[10]

After World War II, there was a significant increase in medical knowledge and technologies, enabling patients to live longer with more complicated diseases.[10,11] This challenged the practice of medicine and put more responsibilities on residents' shoulders. The pressure intensified as the number of admissions increased while the length of hospital stays for patients drastically shortened from several months to several weeks, giving residents less time to read, study, and engage in research.[10] Consequently, personal relationships between residents and other medical professionals working at the workplace, such as supervisors or nurses began to disappear, and residents began to live more outside of the hospital. This meant they needed to increasingly balance their work and personal lives.[10] All these changes put a challenge on residency practices.

Luckily, more research occurred on medical education and several pedagogical developments influenced residency. However, the transfer from theory to practice remained difficult to establish, and there was little accountability for those who graduated from residency

programs. From 1983 on, residents had to submit a yearly logbook primarily comprising quantitative data to obtain licensure from the licensing committee.[12] This license was sufficient to practice medicine in the chosen specialty; the physicians' competence was assumed by sufficient exposure to patient care. The training to become a medical specialist had to be recognised by the government, but was not yet affiliated with the university in all cases. A formal integration of theoretical training in residency was not yet established.

The Bologna process, initiated in 1999, changed the landscape of higher education profoundly. Current bachelor, master and doctorate degree cycles were introduced along with the European Credit Transfer System (ECTS).[13,14] For medical education in Belgium specifically, these changes initially took place in UGME. However, in 2009, a significant shift occurred in Belgian PGME as well, with the introduction of the 'Master of Specialistic Medicine' (MSM), preceded by the introduction of the 'Master of Medicine in Family Medicine' in 2005. The MSM was an Advanced Master program which needed to be followed concurrently with clinical residency.[12] The introduction of the MSM also marked the beginning of all residency programs being officially affiliated with universities. This had two consequences. First, theory was formally integrated into PGME in Belgium. Second, the quantitative logbook was partially replaced by qualitative assessment, relying on written assessments to evaluate residents' competence.

The last change in PGME occurred in 2012, when the Master in Medicine programme was reduced from 240 ECTS to 180 ECTS, according to European requirements.[15] This adjustment shortened the duration of UGME from 7 to 6 years. The postgraduate program of general practitioners (GPs) in training has been extended with 1 year, resulting in the total duration from undergraduate student to licensed GP to remain 9 years. Conversely, while the MSM for this cohort increased from 120 to 180 ECTS, the clinical years of residency in specialised medicine remained unchanged. This reduced the duration from undergraduate student to licensed medical specialist by one year for students starting the UGME in 2012. Figure 1 provides a schematic overview of the current pathway of medical education in Flanders.

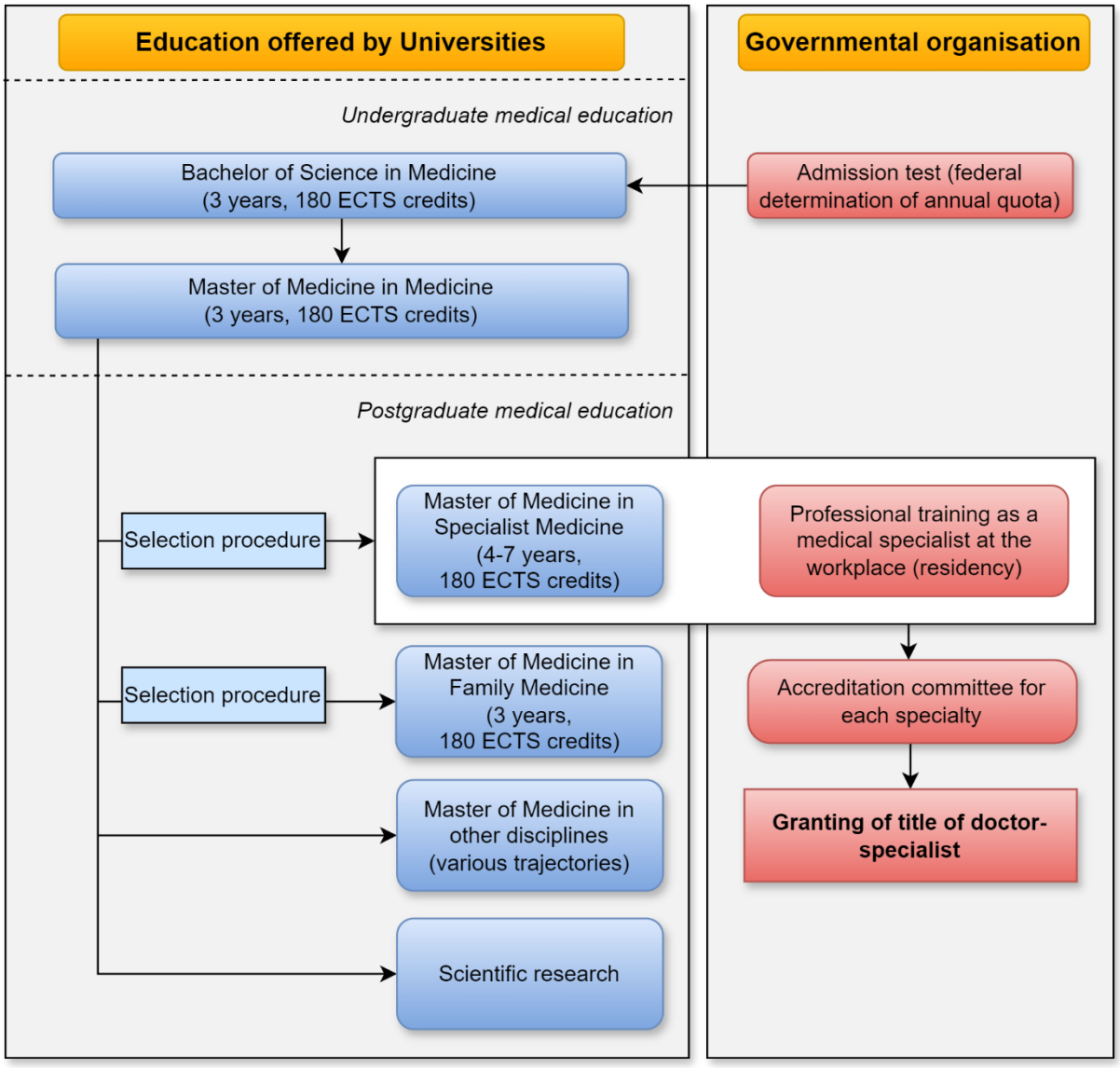


Figure 1: A schematic overview of current Medical Education in Flanders, Belgium anno 2024. The white square represents the two-fold training to become a medical specialist.

2. Workplace learning in postgraduate medical education

The evolution of medical education has shown that finding a balance between theory and practice has always been a challenge. While some departments and supervisors may have intuitively initiated educational practices, such as formal lessons during lunch or journal clubs, the primary source of knowledge and skills in current PGME still derives from patient care during daily practice. It is therefore of utmost importance to investigate and enhance the processes by which a resident becomes a competent medical specialist when engaging in clinical care.[16] This dissertation focuses on three main areas of WPL in PGME. The first is the

workplace, which is where residents spend the majority of their training. The context of learning in the workplace is complex, and the most significant issues will be discussed. The second focus is educational outcomes, often defined as competencies - a concept that has evolved over time and which will be explored in this introduction. The final focus is the learning processes that take place during residency. After these three subjects are introduced, a deeper exploration of current workplace learning theories will follow.

2.1. Focus on the workplace

2.1.1. Definition of workplace learning

In the literature on WPL, several terms have been used interchangeably, including '*workplace-based learning'*, '*workbased learning'*, *'work-integrated learning'*, and *'work-related learning'*. The term WPL was chosen in this dissertation in accordance to Teunissen et al[17], as it represents the broadest interpretation of learning that occurs in the workplace.

Moreover, diverse definitions for the term WPL exist. This dissertation employs an assembly of what is found in the literature: WPL is learning *through (or from)* work and learning *at* work.[18,19] Learning through work in PGME means that the resident performs (supervised) clinical patient care, which provides educational moments. Learning at work encompasses activities that occur at the workplace that do not involve direct patient care such as simulations, theoretical and practical training, and journal clubs, through which residents also acquire knowledge and skills relevant to their profession. Some argue that learning *for* work, such as self-study at home, should also be considered part of WPL. However, this concept leans more towards work-related learning. It will be discussed in '*2.2.4. Currently used frameworks in Flanders*' why it does not fit the definition of WPL used in this dissertation.[20]

Given its multifaceted nature, a range of educational theories and principles can be applied to WPL, some of which will be elucidated in '2.3.1. Workplace learning theories'.[21] Before delving into how learning occurs in PGME, it is essential to understand the context in which WPL is executed, as this context significantly influences how residents learn.

2.1.2. Provision of clinical care

Looking at how residency has evolved, it becomes clear that providing clinical care has always been the core focus. Three important conditions must be met to provide this care: residents

need to spend time in the hospital, they need exposure to patients, and there should be supervisors who are accountable for the actions of the residents.

TIME SPENT IN THE HOSPITAL

The first condition, time spent in the hospital, has undergone changes throughout the last century. As discussed earlier in this introduction, residents in the beginning of the 20th century almost lived in the hospitals, but they later experienced and valued life outside of the hospital as well.[10] However, working weeks still often exceeded 100 working hours, which had significant impact on both residents' well-being and the quality of care. Long working hours, sleep deprivation, sleep restriction, and enforced unnatural circadian cycles all contribute to various negative effects: (1) cognitive and motor impairments, which inevitably lead to errors and thus impairs patient safety[22-24]; (2) an increased risk of injuries and accidents[22,25]; (3) an impaired mental health status[25-27]; and (4) an increased prevalence of cardiovascular disease on workweeks over 55 hours[28].

Recognising the importance of the well-being and safety of residents, their patients and the society as a whole, measures were taken to limit working hours. The European Working Time Directive, initiated in 1993, aimed to address working hours issues in all kinds of professions by stating that working weeks should not exceed 48 hours per week.[22] However, there was an exclusion of physicians (in training) from this directive, which was not lifted until 2004.[22] Then still, there remained an opting-out possibility for physicians to a mean of 60 hours per week with a maximum of 72 hours. However, some supervisors argued that the 60-hour working week decreased patient exposure, thereby hindering residents' learning opportunities and future competence as a graduated specialist.[29,30]

PATIENT EXPOSURE

Some would argue that merely being exposed to patients through clinical service can be seen as educational practices without formal teaching, but WPL does not occur solely through accumulating practice or executing routine work.[31,32] Accumulating practice has a side effect as well: in the current era, all patient care is often accompanied by a significant burden of documentation, which is partly due to the implementation of electronic health records.[33-35] Although it was designed to enhance clinical care by making more information readily available, this does not necessarily mean that the handling and usage of information is

improved. In some cases, such as electronic prescriptions, the workflow may even deteriorate, requiring more steps compared to traditional written prescriptions.[35] As working hours shortened and electronic systems became more prevalent, healthcare professionals increasingly relied on electronic information exchange. This necessitates thorough and clear documentation, consuming more time compared to jotting down a few words on a paper chart. This emphasis on documentation limits direct patient exposure, as residents must allocate time to complete these tasks within their working hours.[33-35] When residents are overloaded with tasks, they tend to prioritise the most urgent ones, which are not necessarily the most important for their learning.[36]

> For example, residents might choose to finish their administrative work first instead of observing an interesting clinical procedure or studying an interesting case.

Even without considering the documentation aspect, there exists a delicate balance between education and patient care, which historically has been tilted toward care.[37] The quality of the training of residents may be compromised when they are burdened with excessive routine work that fails to adequately challenge them within their level of proficiency and fails to stimulate growth.[37] About 80 years ago, it was already advocated that it would be more beneficial for the intellectual growth of residents to study fewer patients in depth than more patients superficially. This implies that residents require sufficient time for clinical encounters, critical thinking, study and reflection on these encounters and that supervisors are available to provide some formal teaching.[27,37,38]

Supervision

Supervisors, who are experienced physicians, play a crucial role in optimising learning in clinical practice while also being accountable for the actions of residents who care for patients under their supervision. In the busy clinical department of the current era, maintaining high-quality patient care becomes even more challenging when managing the dual roles of resident-learners and physician-trainers. It complicates processes to ensure quality of care and quality of learning.[39] Not all residents are at the same level of proficiency and can be entrusted within the same degree of unsupervised medical care provision. This requires flexibility from the supervisor, but also from all professionals at the workplace to manage the

department while providing residents with sufficient opportunities to engage in clinical patient care at an adapted level.

Management of a department becomes even more complex as residents continuously rotate between departments. The latter is necessary for residents to gain exposure to different aspects of their discipline, leading to a thorough understanding of each aspect of their field. However, these frequent rotations often result in residents leaving a department at the moment they are becoming sufficiently experienced to work independently, leading to supervisors investing a lot of time without getting a proper return on their investment.

2.1.3. Provision of learning opportunities

The provision of care has always been imperative in PGME, while the implementation of educational practices such as formal teaching or clinical learning conversations are less straightforward. Merely being exposed to patients and receiving advice from supervisors to provide safe care is insufficient for comprehensive medical learning. It needs to be avoided that residents simply mirror the practices of their superiors without clinical reasoning and understanding the theory behind these practices.[40]

This leads us towards more socially-constructed learning theories, which acknowledge that learning occurs through cooperation between the learners and their environment.[41] The supervisor is the most closely related actor to the resident. Historically, the role of supervisors has gradually evolved in contemporary medical education from a master teaching the apprentice into a more coaching role for several reasons: physicians became more specialised, necessitating residents to be exposed to multiple physicians; there was a need to demonstrate competence to external licensing committees; and there were new insights into how teaching should be conducted.[42]

Educational standards have been integrated into PGME[43], yet many supervisors who guide residents in the workplace lack formal training in pedagogy as this is not a requirement.[44] Feedback on teaching is often limited, and the assumption that anyone can teach is no longer deemed acceptable.[18] Although official residency supervisors ('stagemeesters') are now required to complete train-the-trainer courses to obtain licensure to guide residents within their departments, other physicians in the same department who are not affiliated with the

university are not subject to the same obligations; although they will provide guidance to the resident as well.[44]

Nevertheless, meaningful interactions with all physicians are essential for enhanced learning, emphasising the importance of time spent on role modelling, mentoring and fostering personal relationships.[36] Merely having another professional in the room does not guarantee a meaningful interaction.[36] Examples of what is needed in interactions between residents and supervisors include trust, the provision of constructive and high-quality feedback, clarity of expectations in both directions, effective communication, application of instructional strategies, fostering an open culture for discussing mistakes and uncertainties, encouraging question asking, engaging in clinical reasoning conversations, and cultivating mentoring relationships.[40,42,45,46] This means that all physicians who work together with residents need to have a certain understanding of these concepts.

However, the supervisor and other physicians are not the sole individuals responsible for the guidance of residents, the provision of a safe clinical learning environment (CLE), and the integration of the residents in the department.[42,47] It is unreasonable for them to be held responsible for all learning opportunities. Patients also play a crucial role in residents' learning process, as they need to be open to learners by allowing students into their care and when possible, provide them with feedback.[48] Additionally, all other healthcare professionals in the workplace, who are sometimes numerous, have their role in supporting residents.[16,48] Residents have the opportunity to both learn from and teach their peers, regardless of their level of experience.[45,48]

Furthermore, the hospital can contribute to WPL by optimising the organisation of patient care and maximising the potential of the CLE.[27,49] Similarly, the institution associated with the residency program needs to provide adequate learning sources and a well-designed curriculum.[16,45] This ensures that residents gain a clear understanding of how their residency requirements will be met.

2.1.4. RESEARCH GAP

We have seen many factors influencing WPL in the previous paragraphs. However, to effectively harness the potential of WPL in the unique Flemish context, a deeper and evidence-

based understanding of its operational dynamics is essential. This understanding will enable us to align educational strategies with the specific needs of Flemish residents and supervisors and opportunities inherent in WPL. Thus, we have addressed this research gap in Research Objective 1. The details of the research objectives are elaborated upon in **Chapter 2**.

2.2. FOCUS ON OUTCOMES

2.2.1. THE NEED FOR OUTCOMES

Workplace learning encompasses on-site learning, direct interactions with patients, guidance from supervisors, and collaboration with other healthcare professionals, leading to considerable heterogeneity and unpredictability in residents' daily experiences.[50,51] This poses a significant challenge in aligning licensure with the reality of daily practice and can impact the engagement, confidence and commitment of residents.[16,50] Furthermore, not all learners progress at the same pace, resulting in varying outcomes in time-based education despite expectation of similar competency mastery.[52] This underscores that merely spending a fixed amount of time in clinical practice may be insufficient for becoming a proficient physician, as only time-based assessment fails to adequately measure the acquired competencies.[8,53,54] In addition, it is crucial to enhance the integration of WPL with the formal curriculum's medical knowledge to ensure comprehensive PGME.[50]

Collectively, it became evident that some aspects of healthcare education were suboptimal and that some graduating physicians, educated within a fixed time-based PGME curriculum, lacked the competencies to meet with the complexities of modern practice.[53,54] This realisation marked the beginning of a shift from time-based education to competency-based education around the 1960s, a shift that mirrored developments in industry and higher education in general. [53,55,56] It was believed that competencies could provide a more reliable and transparent means of holding medical education accountable, ensuring that every graduate is fit for practice with a focus on outcomes related to patients, populations and health professions education programs.[53,54,57,58] The principles of competency-based education within the specific context of medical education, also known as competency-based medical education (CBME), emphasise the characteristics of the graduating physician rather than the characteristics of the educational process. [56,59]

2.2.2. Definition of competency-based medical education

Defining CBME is not straightforward, as there are multiple definitions in the literature, some of which overlap. Table 1 presents various definitions.[60]

Reference	Proposed definition of CBME
McGaghie et al in 1978[61]	"The intended output of a competency-based programme is a health professional who can practise medicine at a defined level of proficiency, in accord with local conditions, to meet local needs."
Frank et al in 2010[62]	"An outcomes-based approach to the design, implementation, assessment, and evaluation of medical education programs, using an organizing framework of competencies."
Frank et al in 2010[63]	"An approach to preparing physicians for practice that is fundamentally oriented to graduate outcome abilities and organized around competencies derived from an analysis of societal and patient needs. It deemphasizes time-based training and promises greater accountability, flexibility, and learner centredness."
Ten Cate in 2017[52]	"Education for the medical profession that is targeted at a fixed level of proficiency in one or more medical competencies."
Holmboe et al in 2017[54]	"An approach to and philosophy of designing the explicit developmental progression of health care professionals to meet the needs of those they serve."

Table 1. Proposed definitions of CBME throughout the years.

Although there may be variations in emphasis among the definitions, they all share the underlying assumption that medical education should be structured around predetermined outcomes or competencies. The distinction between the two lies in the following: outcomes represent the expected achievements of students after their formal education, whereas competencies encompass the abilities required to provide adequate patient care.[56,64] The term competence refers to a professional who can apply these competencies in daily practice,

which requires more than a demonstration of isolated competencies.[65] It requires the professional to possess the integrative ability to think, feel and act like a physician.[65]

2.2.3. Principles of competency-based medical education

There are different principles of CBME. First, it emphasises specific outcomes formulated as competencies, which span three domains: cognitive (knowledge), psychomotor (skills), and affective (attitudes).[8,52,58,62,66] Describing medical knowledge or technical skills alone is thus insufficient. It is essential for competencies to be specific, integrative, durable, performance-focused, reflective of external expectations and they should have objective standards leading to criterion-referenced assessment.[52,57,67] While most competencies are measurable, some, such as attitudes, remain important for learning in CBME despite being challenging to objectively assess.[56]

Second, competencies are built on identifying the needs of learners, patients and the healthcare system.[58,64,66,67] They should be under continuous evaluation to stay pertinent, and can differ geographically, based on local needs.

Third, competencies and their developmental markers are sequenced progressively.[57,58,60] This means that the competencies are organised in a way that leads to a logical developmental sequence across the continuum of medical practice, guiding residents from novices to experts.[58,60] The competencies are structured in a competency framework that connects professional practice, education, and assessment.[63,68]

Fourth, time-based education is de-emphasised.[52,57,58,62,64] Individual learners need different educational strategies and progress through levels of performance at different paces. Progression is based on the demonstration of required competencies rather than set timeframes.[57,58]

Fifth, learner-centeredness is promoted.[56,58,60,62,64,66] CBME allows for individualised learning experiences, high-quality feedback, and guided reflection.[58] Although learner-centeredness is promoted, learning remains a shared responsibility between teacher and learner.[57]

Lastly, assessment serves both *of* learning and *for* learning.[69] This involves active trainee involvement in learning and assessment, an authentic CLE, direct observation, and an emphasis on formative feedback.[69]

Several advantages and drawbacks of CBME have been suggested.[54,55,62,66] Advocates underscore its transparency and accountability, and alignment with various theoretical frameworks. They highlight the potential for dynamic adaptation to evolving healthcare delivery needs, as well as its ability to standardise teaching and assessment. Furthermore, CBME is promoted for its potential to establish a true continuum in medical education. On the other hand, critics raise concerns regarding the current system's inability to accommodate time-variable education, potentially leading to chaos.[54,70,71] They also highlight the lack of substantial evidence supporting the effectiveness of CBME on the process of training as well as the training results of residents.[54,71] Furthermore, there is the challenge of defining all necessary competencies for healthcare professionals, leading to reductionism.[54,62,70,71] Concerns also exist regarding the increased administrative burden associated with CBME implementation.[70,71]

The usability in clinical practice is another point of concern. Many competency frameworks consist of long lists of competencies that are difficult to use in practice for training, feedback and assessment purposes. Over the past few years, Entrustable Professional Activities (EPAs) have been created in response to these concerns. They are defined as distinct units of professional practice within each specialty, and are structured descriptions of professional work that are mapped to competencies and/or milestones. This mapping makes the competencies and/or milestones less abstract; therefore, EPAs hold significant face validity for workplace supervisors.[72-75] Regarded a useful conceptualisation to facilitate the individualisation of residency programs and the transition to a time-variable model, EPAs have been transforming curricula in recent years. However, before EPAs can be established, competencies need to be clearly defined because they are a key construct of EPAs.[75]

Shortened example of a paediatric EPA[76]

Care for the newborn up to high care level

Title: Independently leading a neonatology/infant department and performing associated departmental activities

Specifications and limitations: This concerns the independent organisation and performance of departmental activities concerning neonates in the second line.

Setting: a second line neonatology department

Required Knowledge, Skills and Behaviour to perform this EPA.

Knowledge:

- Knowledge of normal growth and development of a newborn
- …

Skills:

- Recognise clinical signs of most common transition problems, illness or other forms of derailment in neonate
- …

Attitude:

- Recognise your own limitations and be able to ask for supervision in time

Compulsory courses: NLS

2.2.4. Currently used frameworks in Flanders

In Flanders, the integration of CBME was seen in the development of the MSM curriculum. This curriculum delineates the minimal common learning outcomes for medical specialists and provides multiple opportunities for the resident to develop, practice and demonstrate competence before they are granted licensure. Although related to WPL, the MSM curriculum is distinct in that it is primarily organised outside of the workplace, hence referred to as learning *for* work.

The current framework for MSM is derived from the original Canadian Medical Education Directives for Specialists (CanMEDS) Roles Framework[77], distributing the 180 ECTS across 4 adapted roles (medical expert, researcher, communicator, manager)[12] along with elective subjects. The MSM integrates clinical, theoretical and scientific courses to achieve all the

specified competencies in their map of learning outcomes.[78] An overview of the MSM curriculum can be found in Figure 2.

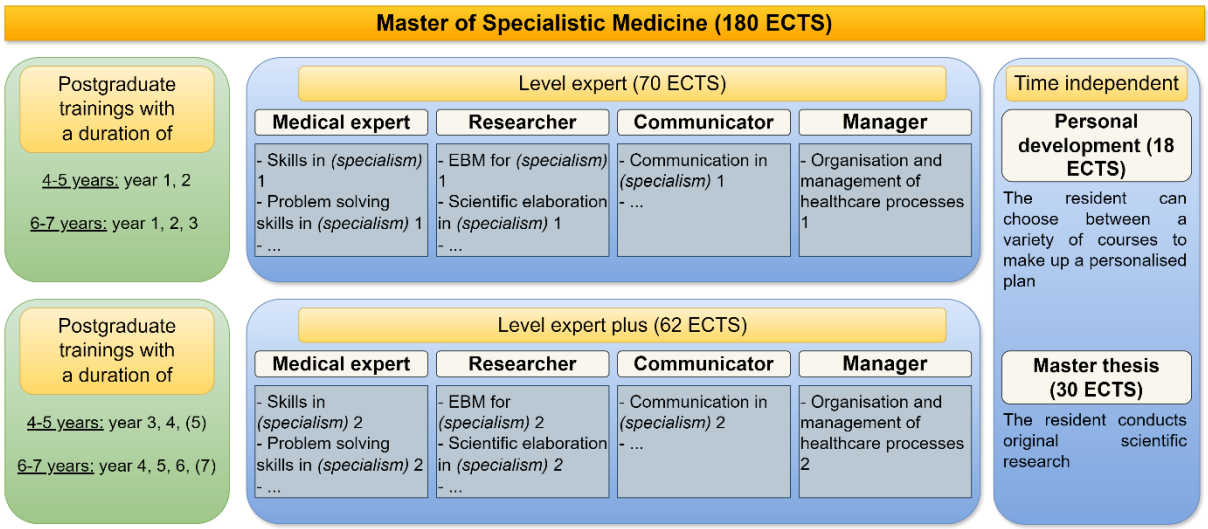


Figure 2: An overview of the Master of Specialistic Medicine curriculum.

It is evident that residents will also need to acquire specialisation-specific competencies. Specifically for paediatrics, the Curriculum for Common Trunk Training in Paediatrics was developed by the European Academy of Paediatrics (EAP).[79]

2.2.5. Research gap

The concurrent use of different frameworks is complex and confusing. Currently, there is no integrated framework that encompasses general and discipline specific outcomes. Thus, we have addressed this research gap in Research Objective 2. The details of the research objectives are elaborated upon in **Chapter 2**.

2.3. Focus on the learning process

The last important focus are the residents and their perceived learning experience. While the CLE is an important stimulus, there are other dependent factors for effective learning within WPL related to residents, such as their interpretation of the facilitators and challenges provided with the CLE, their interaction with that environment, their engagement in personal growth, and the development of their professional identity.[45,80]

Some residents may adopt a surface learning approach, indicating a lack of deeper understanding of the subject matter. In the busy context of WPL in PGME, a surface *rational*

approach can occur due to resident-dependent factors, such as having a preference for order, detail and routine.[36,81] On the other hand, residents can feel overwhelmed by work and clinical duties, feeling to have lack of dedicated time for learning and thus grasping concepts quickly, leading to a surface *disorganised* approach.[36,81] Although the overwhelming feeling of busy clinical practice is a real and valuable experience, it should not be the standard throughout residency.

A deep approach to learning, where experiences are processed, is essential for giving meaning to what has happened and thus facilitating information retention with the proper context over time.[82] Interaction with supervisors can stimulate this, as they can ask thought-provoking questions and inspire the resident to reflect on practice.

> For example, when a resident seeks guidance from a supervisor regarding a patient's management plan and the supervisor makes revisions, there are two options. A surface learning approach would mean that the resident merely accepts the new plan and subsequently applies the same management strategy to a future, comparable patient. Conversely, a deep learning approach would mean that the resident reflects on the shortcomings of the original plan, posing inquiries, or consulting literature to discern the rationale behind the supervisor's plan, and identifying those characteristics essential for the effective application of the same plan to a future, comparable patient.

This example raises the question: how can a deep approach to learning be stimulated within the resident? Understanding the learning process necessitates the use of educational theories. Theoretical frameworks and models are key for characterising features, conducting research, and serving as a basis for curriculum development.[50] However, no single theory incorporates all aspects of WPL, and several have been discussed in the light of WPL practices.[83,84] For the purpose of this dissertation, there will be a focus on those theories that are most pertinent to the research objectives.

2.3.1. WORKPLACE LEARNING THEORIES

Most WPL occurs informally, taking place outside formal education and training settings.[16,85] Eraut distinguishes three levels of intention in informal learning: implicit learning, reactive learning and deliberative learning.[85] Implicit learning occurs without conscious efforts to

learn. Reactive learning is intentional, but it occurs during an action when there is little time to think. However, this input can be the inspiration to perform deliberative learning, which involves considered and planned efforts.[85] For these deliberate practices to occur, it is essential to recognise the areas of performance that require improvement, establish clear objectives for improvement in these areas, and formulate a structured plan.[86] Deliberative learning has many similarities with self-regulated learning, which refers to self-generated thoughts, feelings and actions that are strategically planned and adapted to the attainment of personal goals.[86]

Learning in the workplace is also experiential in nature, as defined by Keeton and Tate in 1978: "Learning in which the learner is directly in touch with the realities being studied. It is contrasted with the learner who only reads about, hears about, talks about, or writes about these realities but never comes into contact with them as part of the learning process".[87] A few years later, Kolb developed his Experiential Learning Theory (ELT), drawing on the works of previous foundational scholars such as Dewey, Lewin, Piaget and others.[87,88] It integrates experience, perception, cognition and behaviour in the learning process. The ELT comprises a cycle with four stages, namely experiencing, reflecting, thinking, and acting.[50,88-90] Although the theory has faced criticism regarding the rigidity of the cycle, it remains widely used and discussed.[85]

What deliberative learning and the ELT have in common is the concept of self-reflection. Self-reflection is, as defined by Sandars, "a *metacognitive process that occurs before, during and after situations with the purpose of developing greater understanding of both the self and the situation so that future encounters with the situation are informed from previous encounters*".[91] The primary focus lies in understanding what occurred in order to inform future practice, a concept sometimes confused with the term self-assessment, which involves judging performance against perceived norms.[92,93] Although self-reflection can be a component of the self-assessment process, it emphasises the learning process rather than the outcomes.

Guided reflection can provide context to past events, because it requires considerable self-awareness and a strong disposition to monitor one's action while guarding against bias. Bias can stem from emotions, past experiences, and the tendency to remember atypical events

more vividly than typical ones.[85] To offer a more objective perspective, it can be beneficial to have someone present for reflection. This person was either involved in the event or possesses significant experience. Either way, they need to be able to provide additional context or alternative viewpoints.[91] However, it is not always feasible to have guidance available every time a resident wishes to reflect. Therefore, it is necessary to explore alternative methods for guiding reflection. In the current era, technology can also serve as a means of supporting reflection and learning.

2.3.2. The role of technology to support the learning process

When considering technology to support reflection, electronic portfolios (ePortfolios) emerge as a viable option.[94] Portfolios, traditionally employed for centuries in the arts to exhibit one's work, were first formally acknowledged in educational literature in 1978.[95] They serve as comprehensive collections of information and its digital counterpart, the ePortfolio, is widely utilised in PGME.[96,97] It serves multiple purposes beyond reflective practice, including serving as a logbook, facilitating feedback and assessment, and supporting learning.[97]

This dissertation was part of the Strategic Basic Research ('*Strategisch BasisOnderzoek',* SBO) Scaffold project, a four-year interdisciplinary project aimed at enhancing the quality of healthcare education in Flanders through innovative technological applications, such as an ePortfolio. While an ePortfolio can facilitate reflection, it does not inherently provide a more objective perspective on learning events. For this, it needs to have specific features to support reflection.

The incorporation of video into the ePortfolio can serve as an additional feature, as it is a technology that offers deeper insights into past learning events.[98-103] Recording residents during clinical care yields videos that capture their actions within an authentic context. This can support the resident's reflection practices by minimising the discrepancy between their perceived performance and their actual performance. The learning events can be recalled in a realistic context, enabling the identification of previously missed aspects.[98-103] Currently, video recordings are commonly used in both UGME and PGME.[104-109] However, most studies focus either on feasibility, or on the learning effect in a setting where a camera is already part of routine patient care.[106,108-111]

2.3.3 RESEARCH GAP

While video recordings are widely utilised in medical education, their specific role in supporting learning during WPL remains largely unexplored. Thus, we have addressed this research gap in Research Objective 3.

Additionally, within PGME in Flanders, there exists a notable absence of studies evaluating how video review can facilitate reflection during WPL outside of simulation settings. Thus, we have formulated Research Objective 4. The details of the research objectives are elaborated upon in **Chapter 2**.

Chapter 2:
Research objectives and outline

"Science, in the very act of solving problems, creates more of them."

Abraham Flexner

1. RESEARCH OBJECTIVES

The main aim of this dissertation was to investigate how workplace learning (WPL) in postgraduate medical education (PGME) in Flanders could be optimised. Support for the two main groups, residents and supervisors, was a main goal here. To answer this research question, different research objectives were established to address the previously mentioned research gaps.

Research objective 1:

To identify the main enablers and challenges of residents and their supervisors, involved in the training of hospital specialists across different medical specialties and clinical teaching departments. (**Chapter 3**)

Research objective 2:

To develop and validate an integrated competency framework for postgraduate paediatric education. (**Chapter 4**)

Research objective 3:

To examine the contemporary body of literature assessing the educational efficacy of video review in postgraduate medical education. (**Chapter 5**)

Research objective 4:

To investigate the feasibility of video review and its effect on self-reflection for residents in a neonatal intensive care unit. (**Chapter 6**)

2. OUTLINE OF THE DISSERTATION

This dissertation consists of seven chapters. **Chapter 1** is a general introduction on WPL in PGME, introducing key concepts and highlighting gaps in current understanding. Current **chapter 2** provides an overview of the research questions and an outline of the subsequent chapters. Figure 3 gives a visual overview, delineating the structure of this dissertation.

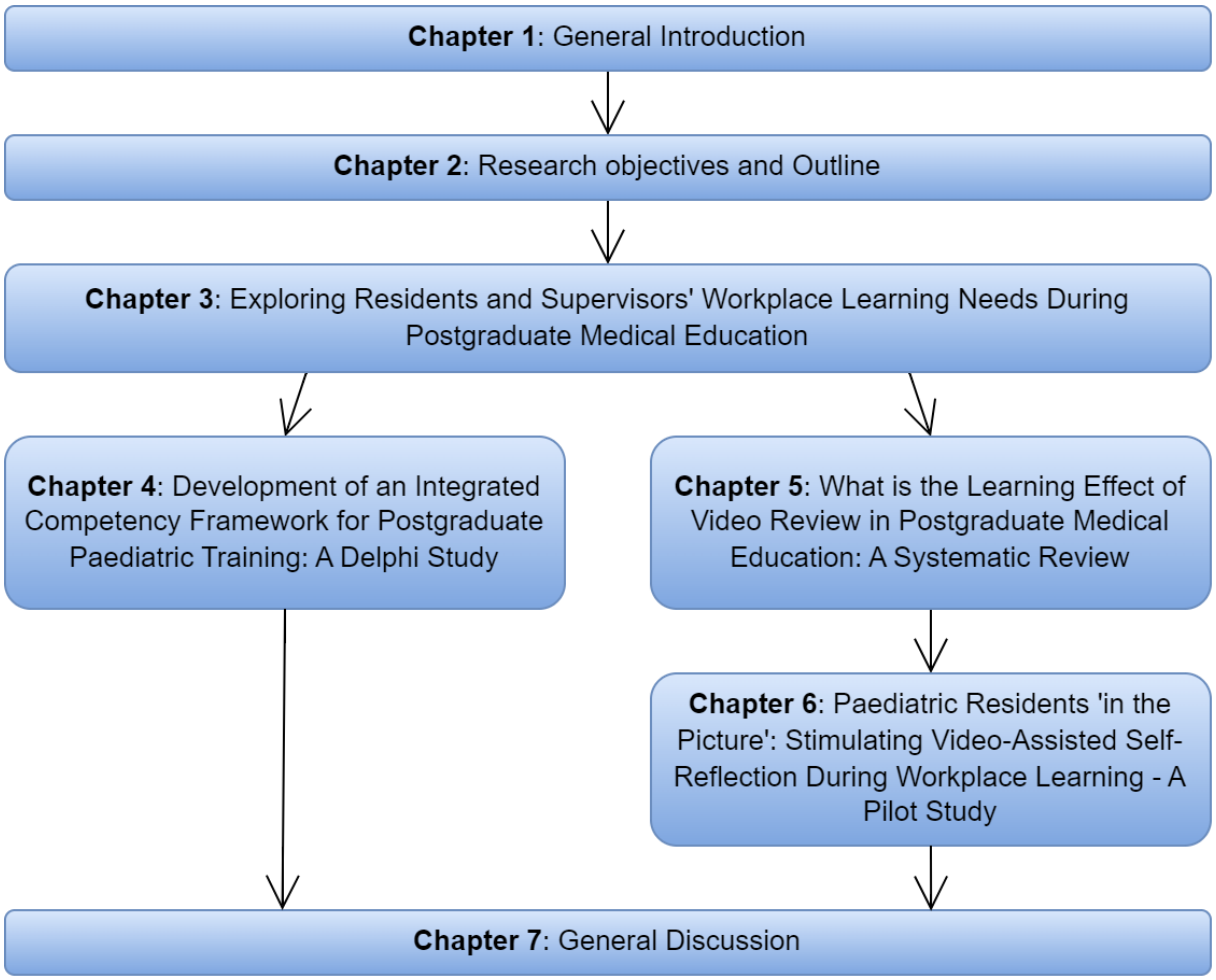


Figure 3: outline of the thesis.

Chapters 3 to 6 present empirical studies, drawn from articles that either were published or submitted for publication in international peer-reviewed journals. In **Chapter 3**, we delve into research objective 1, which involves identifying both enablers and challenges of residents and their supervisors during WPL. Focus group discussions were conducted with both groups to uncover valuable insights.

Our findings revealed two significant areas of concern. First, both supervisors and residents acknowledged that the concurrent use of multiple competency frameworks was confusing and complex. This prompted us to pursue research objective 2, the development and validation of an integrated competency framework for postgraduate paediatric education, which is discussed in **Chapter 4**.

Second, both groups indicated that there was a lack of direct observation to enhance feedback practices and that little encouragement for reflection was present. In response to this, we

explored the potential of technology, particularly video review, as outlined in research objective 3, to examine the contemporary body of literature assessing the educational efficacy of video review in PGME. The systematic review that investigates this research question is presented in **Chapter 5**.

Encouraged by the positive outcomes of the systematic review, we proceeded to investigate the feasibility and impact of video review in paediatric PGME, as outlined in research objective 4 and detailed in **Chapter 6** through a pilot study conducted in a neonatal intensive care unit.

Chapter 7 serves as a platform for a broader discussion, reflecting on the implications of our findings and outlining potential future directions for educators and institutions. A summary is provided both in English and Dutch, the native language of the universities where this thesis was conducted.

Chapter 3:
Exploring residents and supervisors' workplace learning needs during postgraduate medical education

"He who studies medicine without books sails an uncharted sea,

but he who studies medicine without patients does not go to sea at all."

William Osler

Based on:

Robbrecht, M., Van Winckel, M., Norga, K., & Embo, M. (2023). Exploring residents and supervisors' workplace learning needs during postgraduate medical education. International journal of medical education, 14, 65.

1. Abstract

Objectives:

The research question posed in this study is to identify the main enablers and challenges for workplace learning during postgraduate medical education among residents and their supervisors involved in training hospital specialists across different medical specialties and clinical teaching departments.

Methods:

A qualitative explorative study using semi-structured focus group interviews was employed. A convenience sampling method was used to invite participants who were involved in postgraduate medical education for hospital specialist medicine at two universities. Hospital physicians in training, also called residents (n=876) and supervisors (n=66), were invited by email to participate. Three focus groups were organised: two with residents (n=14, n=19) and one with supervisors (n=9). Due to the COVID-19 pandemic rules prohibiting real group meetings, these focus groups were online and asynchronous. The data was analysed following an inductive thematic analysis.

Results:

The following overarching themes were identified: 1) the dual learning path, which balances working in the hospital and formal courses, 2) feedback, where quality, quantity, and frequency are discussed, and 3) learning support, including residents' self-directed learning, supervisors' guidance, and ePortfolio support.

Conclusions:

Different enablers and challenges for postgraduate medical education were identified. These results can guide all stakeholders involved with workplace learning to develop a better understanding of how workplace learning can be optimised to improve the postgraduate medical education experience. Future studies could focus on confirming the results of this study in a broader, perhaps international setting and exploring strategies for aligning residencies to improve quality.

2. INTRODUCTION

Postgraduate medical education (PGME) plays a critical role in the development of medical specialists, equipping them with the knowledge and skills necessary to provide high-quality patient care. Traditionally, PGME is based on workplace learning (WPL), which provides a hands-on approach to learning and assessment during real-life patient care.[18,39,112,113] It is an effective way for medical residents to acquire the necessary competencies to function as independent physicians.

The use of WPL has evolved throughout the last decades in response to changes in medical and technological advancements, as well as societal and political demands for proof of competency.[16,114] This shift in focus has led scientific research to explore the learning processes that occur in the clinical workplace.[36] As a result, there has been an increase in the literature examining the enablers and challenges of WPL practices in clinical settings.[50,112,113,115-118]

The majority of literature on residents' and supervisors' experiences has focused on specific educational topics, such as workplace-based assessment and feedback, or disciplines, such as internal or surgical medicine.[119-122] However, there is little research on the overarching features of WPL practices across various medical specialties and clinical learning departments. Therefore, it is valuable to investigate the use of WPL programs. This will help to identify factors that contribute to their success.

This study is part of a larger multidisciplinary research project. We conducted a qualitative study that aimed to understand the current needs of residents and supervisors during WPL. The research question of this study is to identify the main enablers and challenges of residents and their supervisors, involved in the training of hospital specialists across different medical specialties and clinical teaching departments.

3. METHODS

STUDY SETTING

This study was carried out in the context of PGME for hospital specialist medicine in Flanders, Belgium. Medical students who have completed the six-year undergraduate and graduate medical curriculum (Bachelor's and Master's degrees) are eligible to apply directly for a hospital specialist medical training curriculum that lasts for four to six years.

The hospital specialist training curriculum consists of two parts. The first part is a WPL curriculum that takes place at different clinical training sites licensed for the specialty. The candidates for hospital specialist training, also known as residents, usually rotate every three to twelve months within and between different hospitals in and outside of Belgium. As employees of the hospital, they are expected to provide clinical care and are mentored by staff physicians who act as their supervisors. Many hospitals provide training to residents from different universities. An ePortfolio tool is used to support the learning process and evaluate their learning progress.

The second part of the curriculum is the Master of Specialistic Medicine (MSM) curriculum, which is completed at the residents' university. This curriculum consists of theoretical courses, practical training, assessment, and a master's thesis. While the MSM curriculum is separate from the workplace curriculum, it is organised during the same years. Clinical evaluations by supervisors and annual reports from the input in the ePortfolio, together with successful completion of the Masters' degree, are evaluated by a licensing committee that advises the Flemish authorities to issue the license to practice as a medical specialist at the end of training.

STUDY DESIGN AND PARTICIPANTS

A qualitative exploratory study was conducted using focus group interviews to thoroughly explore the needs of residents and supervisors regarding WPL, aligning with a phenomenological approach to qualitative research.[123] A convenience sampling method was used to invite participants who were involved in PGME for hospital specialist medicine.[124] The study was conducted at Ghent University and University of Antwerp. In April 2020, residents (n=876) and supervisors (n=66) were invited to participate by email. Participants who responded positively (residents n=65, supervisors n=13) were provided with a link for registration to the online focus group tool. Three focus groups were conducted with all participants who registered themselves through the link: one with supervisors (n=9) and two with residents (n=14, n=19). All groups consisted of mixed genders and participants with various years of experience. The group of residents consisted of surgical (n=10), internal (n=16), and other (n=6) disciplines. For one resident there was no demographic data available.

The group of supervisors consisted of clinicians from surgical (n=3), internal (n=3), and other (n=2) disciplines. Also, one curriculum manager participated.

To encourage participants to express their thoughts and perceptions freely, they were given the option to anonymise themselves using nicknames. Approval from the Ethical Committee of Ghent University (BC-07808) was obtained, and all registered participants provided written informed consent prior to the focus group sessions.

Focus groups

Focus groups were organised to gain insight into participants' thoughts and to allow interaction between participants. Due to the COVID-19 pandemic, physical group meetings were not feasible; therefore, online asynchronous focus groups were organised instead. Separate focus groups were conducted for residents and supervisors to allow participants to express their opinions freely among peers and to identify any differences in perceptions between the two groups.[125]

Data collection

Data for the study were collected from May to July 2020 using the online tool FocusGroupIT. The focus groups were moderated by researchers affiliated with the SBO Scaffold project (AA, MR, SVO) with backgrounds in communication sciences, medicine, and educational sciences. The focus groups discussed topics such as the course of a working day, positive and negative experiences regarding WPL, feedback and evaluation, training, and learning goals. A complete overview of these questions can be found in Supplementary Files 1 and 2.

For each focus group, a two-week period was allocated during which a new topic was posted every three days, accompanied by three to four questions. Participants were able to respond electronically at any time convenient to them. The responses were in free text format and visible to all participants, allowing them to read each other's contributions. The moderators encouraged interaction and introduced clarifying questions when appropriate. Participants were notified via email when a new topic or comment was posted. After each focus group, an excerpt of the responses was downloaded in PDF format. The researchers used information sufficiency of answers as a criterion to decide when no further recruitment was necessary.[126]

Data analysis

An inductive codebook approach to thematic analysis was employed using NVivo 12.[127] A codebook approach is situated in the middle of the spectrum between coding reliability approaches, which conceptualise coding as a process of identifying evidence for themes, and reflexive approaches, which allows for more flexibility and interpretative work of the researchers.[128] The analysis was inductive because themes were developed by the researchers and emerged from the data after iterative reading. The analysis involved six phases, fitting within a reflexive approach to thematic analysis.[129] The first author (MR) conducted all six phases. To ensure triangulation of coders, fitting within a coding reliability approach, two other researchers (ME, HD) conducted independent parallel coding in phases one to four. In the first phase, the researchers became familiar with the data by reading and highlighting meaningful data. The second phase consisted of generating initial codes that were meaningful to the research question. In the third phase, initial codes that were found to be similar were grouped to identify recurring themes. The fourth phase comprised reviewing the themes. In the fifth phase, themes were clustered and defined into themes and sub-themes. In the final phase, the report was written.

4. RESULTS

Within our analysis, we were able to retain three themes clustering eight sub-themes. The most relevant information about each theme is presented below. Table 1 summarises the main findings of this explorative study, explaining them in more detail in what follows.

4.1. DUAL LEARNING PATH

As described in the study context, residents follow a curriculum consisting of two parts at the same time. They complete their training both on the job during clinical practice (WPL) and during formal courses and informal training moments (MSM). Perceived enablers and challenges are described within this overarching theme.

4.1.1. WORKPLACE LEARNING

Most residents perceived being actively involved in performing various aspects of the job as most valuable for their learning, such as direct patient contact, discussions with supervisors, group discussions on patients, interaction with peers, and presentations on clinical cases. Additionally, residents highlighted that direct observation by experienced professionals and

gradually gaining increasing independence in a safe clinical learning environment (CLE) were key factors for a positive WPL experience.

> "I love this!!! So on the one hand, this gives me all the independence I want, but on the other hand, I always do this in a safe learning environment where I get lots of feedback daily!" (Resident1, internal specialty)

While residents reported positive learning experiences, they also identified several areas for improvement, with the most common concern being the inadequate provision of protected educational time for learning and supervision within the workplace. According to the residents, there was an imbalance between work and learning, which was attributed to either the demands of the clinical department or the significant amount of time spent on administrative tasks related to patient care that did not contribute effectively to their clinical competency development. Supervisors were willing to provide more guidance but were unable to do so because of time constraints, which many residents acknowledged. Conversely, one supervisor suggested that some residents purposefully did not engage with their clinical development and hid in the clinical workflow. Both supervisors and residents expressed a desire for more time explicitly dedicated to educational activities.

> "General frustration of probably many people will be that no specific time is set aside (for both parties)" (Supervisor1, surgical specialty)

> "Depending on location, the resident is still often seen as a cheap labour force that has to work a lot, rather than a colleague you train and invest in" (Resident2, other specialty)

> "Doing (part of) an operation yourself, under immediate supervision with immediate feedback, is extremely rare as it would be too much of a waste of time..." (Resident3, surgical specialty)

The lack of an educational culture was another significant problem identified by the participants. Specifically, they reported often missing a clear training structure that offered a complete range of clinical experiences throughout the different rotations. Additionally, participants mentioned the highly variable quality of supervision and educational opportunities.

> "Rotations, where I learned a lot, are the rotations in which staff members shared their experience with you, explained certain tasks to you, and then systematically gave you more independence in those tasks. Rotations where you can work out projects instead of just running routine." (Resident4, other specialty)

4.1.2. MSM CURRICULUM

The analysis revealed several concerns related to the added value of the MSM curriculum by residents. There were concerns regarding the frequency, location, and content of courses and skills training. Residents expressed appreciation for regularly scheduled courses, but also noted significant variation in the frequency of sessions, ranging from once a week to twice a year. Overall, residents felt that there were generally too few courses offered.

Residents also appreciated the option of virtual courses, which allowed them to review material at their own pace and convenience. Although face-to-face courses were seen as more stimulating and effective for learning, residents perceived them often as difficult to attend during working hours due to workplace distractions such as interrupting phone calls or clinical demands for which they were responsible.

Residents also commented on the content of the courses. Participants reported that courses related to daily practice were seen as relevant and immediately applicable to their work, opposed to frequent lectures on exceptional cases. However, they reported that there was too little choice given to the resident regarding the content of the courses they were required to take. Additionally, there was a perception that the courses lacked structure and that too few were taught by experts in the field.

> "Occasionally there are classes by supervisors (actually too few, because these are more useful than yet another rare case presented by a fellow resident)." (Resident2, other specialty)

> "I sometimes find it absurd how many credits we have to pay the university for "courses" that have no class content but require us to complete assignments or submit the number of conference hours for example." (Resident5, internal specialty)

The tasks that were given in some courses were described as not always relevant and sometimes even useless. Residents also reported a lack of training related to technical skills,

which were highly needed as time constraints on the job hindered their ability to gradually develop these skills during clinical care.

> "You are supposed to learn this in the workplace but when you start as a resident [...] there is sometimes little time to learn a skill thoroughly. [...] Unfortunately, in practice you often have to be able to do it right away if you have seen it once or twice." (Resident6, internal specialty)

Residents also expressed a desire to learn transferable skills that could be applied across a range of clinical settings. These skills included clinical time management, stress management, and providing feedback to colleagues.

Another aspect of the MSM curriculum includes the competencies or training that form the basis of the curriculum. The lack of clearly defined training objectives was a challenge for both residents and supervisors. In some cases, the objectives were not provided or were unknown, and in other cases, multiple lists of objectives existed, which created confusion for residents and made it difficult for supervisors to monitor residents' learning. This also made it challenging to work with learning goals. Both residents and supervisors often failed to follow up on learning goals. Additionally, many residents admitted to not formulating these goals, despite recognising their usefulness.

> "I was never asked to formulate goals, but I would find this particularly useful. Ideally, supervisors should also be aware of the goals you have formulated for yourself so that they can pay extra attention to this." (Resident7, internal specialty)

Residents appreciated examinations related to their specialty; however, they felt that the theoretical preparation for these exams was inadequate.

> "But the training here could provide more structure and guidance. Suddenly we are residents and good courses seem superfluous, while we still have to take exams." (Resident6, internal specialty)

4.2. Feedback

Feedback includes formative and summative feedback because participants made no difference between both feedback formats.

4.2.1. FREQUENCY AND TIMING

When analysing the frequency and timing of feedback, only a minority of residents indicated that feedback was given systematically or scheduled. Regarding timing, several residents indicated that feedback was provided during or just after the learning event, but the majority stated that feedback was delayed or not provided at all.

> "Feedback is often written afterwards via [the current ePortfolio]. But often comes a while later, making it not as relevant." (Resident8, internal specialty)

> "But for the first 2 years of my training, it was hoping you did it right and trying to look up a lot in the literature when in doubt." (Resident9, other specialty)

Supervisors indicated that a high resident turnover was associated with repeating the same feedback to different residents, which lead to induced feedback fatigue. This turnover also hindered feedback on the process of continuous development of competencies over time.

In terms of quantity and responsibility for initiating feedback, there was a mismatch in perceptions between residents and supervisors. Some supervisors felt that they provided a lot of feedback, but believed that residents should take the initiative to ask for feedback. Residents, on the other hand, reported receiving too little feedback and expressed a desire for supervisors to give feedback more spontaneously or provide high-quality feedback when asked for it. The following quotes exemplify this problem:

> "The resident is expected to ask for feedback himself, but this rarely happens." (Supervisor2, internal specialty)

> "We have to make up for ourselves all those evaluation forms in the ePortfolio, which are then simply validated by supervisors without a conversation." (Resident2, other specialty)

4.2.2. QUALITY

The analysis revealed various issues related to the quality of feedback. Supervisors stated that many colleagues hesitated to give critique on residents and find it hard to provide constructive feedback, which left many areas for improvement undiscussed. A similar result was found in the focus groups of the residents, who felt that feedback was frequently only given if something went wrong.

Additionally, residents missed specific positive enforcement as this would provide them with a clearer image of their performances. Most residents reported a low quality of the feedback they received. They found it superficial and lacking in added value for their self-reflection. However, residents acknowledged that the quality of feedback was highly variable among supervisors and praised those supervisors who took the time to provide high-quality feedback.

> "I really hate these feedback moments where they just say 'it was good'." (Resident10, internal specialty)

> "I spent at least an hour once […] with a fantastic supervisor who gave me a super comprehensive evaluation. He had really observed and assessed me. Cited points I knew about myself, but also brought new insights. But that takes time..." (Resident11, internal specialty)

> "Evaluation moments are rated as a chore, little time is spent on this unless negative, and one 'has to' say something about it. Compliments are seldom given in the workplace, much is taken for granted." (Resident12, surgical specialty)

4.2.3. Two-way feedback

Several supervisors believed that receiving feedback from residents would be beneficial. However, only a small number of residents reported being involved in a two-way feedback process. Some residents reported that the current feedback culture did not provide the opportunity to do so, or felt that feedback towards supervisors was not appreciated.

> "There should also be more feedback from the resident on your performance as an educator." (Supervisor2, internal specialty)

4.3. Supporting the learning process

The participants described different actors and tools playing a role in supporting the learning process.

4.3.1 Residents' self-directed learning process

Residents reported that they mostly engaged in self-assessment when it was assigned as a task or in preparation for a formal assessment. However, in daily practice, many residents struggled with adequate self-assessments as they lacked feedback from others on their performances and tended to compare themselves with their peers instead.

> "I've become more confident in what I'm doing, but I have no idea if I'm doing it right. It has happened several times before that I do something in the way that I think I am doing it correctly, only to be told by accident (for example, as a comment to someone else) that something should actually be done differently." (Resident9, other specialty)

Engaging in research and self-study are important aspects of the expected self-directed learning attitude of residents. While residents are motivated to take an active role in their learning, they sometimes felt overwhelmed by the vast amount of available literature. Despite seeking urgently needed case-related information during clinical encounters, they may struggle to perform a critical appraisal and conduct deeper research due to time constraints imposed by the clinic's pressures.

> "The range of study materials is so vast that as a resident it is not always easy to know where to start." (Resident6, internal specialty)

> "At work itself, little effective time is sometimes provided for e.g. scientific work, looking things up, making Master's degree related tasks. The 60 hours that you are supposed to work weekly are often occupied with your patients, the many administrative tasks that come along with it, etc." (Resident13, internal specialty)

While many residents acknowledged the importance of having a self-directed learning attitude, there is still room for improvement in their ability to master self-directed learning skills and supervisors also needed more information on how they could guide residents in acquiring these skills:

> "Many [residents] have not mastered self-directed learning at the start [of their residency], and info and guidance for supervisors and residents is desirable." (Supervisor3, internal specialty)

4.3.2. SUPERVISORS' GUIDANCE

Residents described their most valuable supervisors as those who fostered learning by 1) asking questions, 2) providing a safe environment for patients and residents - even if residents make mistakes, 3) and offering adequate follow-up and feedback, while thinking together with the resident. They also appreciated supervisors who explained their clinical reasoning during patient care. Although supervisors were, in most cases, easily accessible by phone, they mainly

provided only brief advice without additional information. Residents highly valued supervisors with strong teaching skills and motivation to guide residents, but perceived important differences between supervisors.

> "In other places, you are left more on your own and you work mainly independently with short telephone consultations. You will have to do more research on your own to refine your knowledge, but this is less efficient." (Resident14, internal specialty)

Residents felt that equality and connectedness in their relationship with supervisors empowered their learning process, whereas a hierarchical structure had an inhibiting effect:

> "Others rely more on the hierarchy and then you almost don't dare to approach them." (Resident2, other specialty)

Scaffolding the learning process was challenging as both supervisors and residents acknowledged the importance of direct observation to provide high-quality feedback, but there were limited opportunities for the supervisor to be present at the patient encounter. Many residents mentioned gradually being entrusted with increasing responsibilities over time, but others experienced the opposite and were overwhelmed with responsibilities that exceeded their capabilities.

> "We often just accompany the supervisor and stand around watching." (Resident14, internal specialty)

> "While you are still basically just "tagging along" during your last days as an intern, a month after graduation you are dropped into a hospital and have to do a 24-hour on-call shift in emergency rooms on day 4. From no responsibility to lots of responsibility, without a decent transition period." (Resident15, internal specialty)

The supervisors indicated that they struggled to combine all their different tasks with their teaching responsibilities. Again, one major reason for this was a lack of protected time to supervise a large number of residents.

> "Maybe the function [of supervisor] should be much more untwined from clinical duties and other staff members can be involved. This is difficult because we have a lot of residents, and good supervision takes a lot of time." (Supervisor4, internal specialty)

4.3.3. ePortfolio support

The role of the currently used ePortfolio elicited mixed feelings among residents and supervisors. While the majority of residents perceived it as merely a logbook, lacking in support for their learning process, some recognised its potential to facilitate educational conversations and foster deep self-reflection. However, these individuals felt that the ePortfolio was not being utilised to its fullest extent.

> "I also find that on that front, [the current ePortfolio] sometimes feels more like an administrative task that you have to add to get your recognition rather than a real learning platform or a tool where you can track your own goals and progress." (Resident16, surgical specialty)

Supervisors held mixed opinions on the role of the ePortfolio in supporting the long-term follow-up of residents as documented in the following quote:

> "[The ePortfolio] allows logging what a resident has seen/experienced, to what extent he/she is considered competent on the different rotations where he/she has worked. Nevertheless, it remains difficult to deduce from [the ePortfolio] whether the training goals have all been met, those goals can certainly be formulated even more concretely and completely." (Supervisor3, internal specialty)

Table 1. Summary of enablers and challenges during WPL in PGME

Theme	Subtheme	Enablers	Challenges
Dual learning path	**Workplace learning**	Being actively involved in performing various aspects of the job	Too little training time with an imbalance between working, and learning or teaching
			Not experiencing an educational culture
	MSM curriculum	Regularly organised courses	Frequency is highly variable
		Virtually available courses	Too little choice in offered courses
		Physically organised courses	Lacking structure in offered courses
		Courses compliant with daily clinical practice	Many distractions during physical courses
		Discipline-specific exam	The imbalance between courses given by peers and by experienced professionals
			Insufficient training in technical skills
			Insufficient training in transferable skills
			The MSM curriculum is perceived as separated on top of WPL
			Clearly defined training objectives not available or being unclear
			Preparation for the discipline-specific exam
Feedback	**Frequency and timing**	Systematic and scheduled feedback	Feedback being given far later than the learning experience or event
			No feedback is given at all
			Feedback fatigue due to high resident turnover
			Opposing perceptions between residents and supervisors about the quantity of feedback
			Opposing perceptions between residents and supervisors' responsibility for initiating feedback.
	Quality	Mentioning points of improvement during feedback	Lacking positive enforcement

			Poor quality of feedback
	Two-way feedback	Supervisors wanting feedback about themselves	Residents finding few opportunities to provide supervisors with feedback
Learning support	**Residents' self-directed learning**	Self-reflection included in assignments and ePortfolio	Self-reflection is complicated by lack of external input
		Research and self-study are useful	Little guidance with self-study
		Self-directed learning attitude is perceived as important	Insufficient time for self-study
			Self-directed learning skills are not mastered by all residents
			Supervisors are in need of information on how to provide proper guidance to master self-directed learning skills
	Supervisors' guidance	Encouraging supervisors who ask questions, provide opportunity to safely fail with proper feedback, share clinical reasoning, share knowledge	Wide variation in perception regarding educational competencies of supervisors
		Supervisors being easily accessible	Solely receiving brief advice when asking for help
		Residents being considered as colleagues	A strict hierarchical structure between residents and supervisors
		Direct observation of residents	Insufficient opportunities for direct observation
		Progressively becoming more independent in a safe learning environment	Bearing inappropriate amount of responsibility (too much or too little)
			Lack of protected time for educational activities by supervisors
	ePortfolio support	ePortfolio stimulates learning conversations	ePortfolio mainly considered a logbook instead of a tool to support the learning process

5. DISCUSSION

This study aimed to identify the main enablers and challenges of WPL for residents and their supervisors involved in training hospital specialists across different medical specialties and clinical learning departments. Our results, summarised in Table 1, highlight various areas that can inform the development of WPL programs.

The first theme of our study focuses on the dual learning path, which consists of WPL and formal teaching sessions. While not all countries offer a MSM, PGME usually involves a combination of WPL and formal lessons. Our results indicate that both entities currently have their value, but there is still room for improvement in balancing working and learning. Time constraints are often cited as a challenge,[36,130] as participants reported frustration regarding non-educational patient care administrative tasks and the lack of protected time for structured formal learning.[131] The focus groups revealed that there is often insufficient time available at the workplace to dedicate to education, which is reflected in several themes. While supervisors and residents can optimise their available time, the implementation of their clinical time is beyond their control. Obligations, organisation, and budgeting have an important influence on the time use of both parties during working hours and it is essential to consider education in organizational structures.[37,132]

According to our results, training objectives were not being utilised effectively, and many residents reported that the existing training objectives were not sufficiently clear, which was felt to have a great impact on WPL as reflected in the existing literature.[36,43] In addition to defining discipline-specific competencies as training objectives, there is a growing need to foster the development of transferable skills, which are increasingly important for physicians in the current medical landscape.[133]

To optimise the PGME experience, it is important to align and complement the training objectives of WPL and formal lessons as they complement each other's deficiencies. Our study highlights that these elements are currently perceived as separate entities, and suggests that the formal lessons would benefit from a clear structure. This would enable residents to construct their program based on their individual learning needs and availabilities, which vary in the unpredictable WPL context with an ill-defined curriculum.[50] To further align WPL and formal courses, there should be a balance between face-to-face and virtual courses.

A second theme in our results was feedback. We found several challenges regarding the frequency, timing, and divergent perspectives between residents and supervisors. Although the theory of providing effective feedback is well-known, it still requires significant attention. To address this issue, a broader foundation for an adapted feedback culture needs to be established and feedback initiatives should become a shared responsibility.[97,134]

The quality of the feedback process was another point of discussion. It is unclear whether feedback quality was indeed insufficient, or whether this was solely the perception of residents. Other studies have also found a discrepancy between the perception of supervisors and residents regarding feedback quality.[120] Another issue was positive reinforcement. Although much research suggests that feedback during WPL is too often only positive, our respondents stated they missed positive reinforcement.[119,135] This reinforcement has been shown to increase confidence in residents, stimulates them to seek more feedback, and fosters a more productive CLE.[136] The residents in our study indicated that positive reinforcement needs to be specific, as a general "well done" is deemed insufficient to effectively identify and maintain desirable behaviours.

Delivering high-quality feedback indeed requires providing specific cues, which in turn requires direct observation of residents.[119] However, our findings suggest that direct observation may not always be feasible or implemented. Video observation could be an opportunity here, as the supervisor no longer needs to be present at the place and time of the residents' clinical work.[137] Similarly, there is minimal interference from the supervisor, who can see the resident at work in a natural situation.[103] In addition, the resident can also observe themselves afterwards, which can make the feedback dialogue more constructive.[100,101,106,137]

The topic of two-way feedback arose spontaneously in all focus group discussions. Although supervisors expressed the need for feedback towards them, residents felt that it was rarely valued when they provided supervisors with feedback. The literature indicates that creating a safe environment for both residents and supervisors is crucial for hierarchically upward feedback to be effective.[138] However, as the current feedback culture still needs improvement, this safe environment may not always be present. Standardised questionnaires might provide a way to introduce upward feedback and allow residents to practice their feedback skills.[138,139]

The third and last theme was learning support. Residents need to develop their self-directed learning skills to support their learning. These skills are essential to achieve the required competencies in complex and unstructured CLEs, such as the clinical workplace.[19,52,131] However, it appears that residents have not yet sufficiently mastered these self-directed skills or that the needed prerequisites, such as time and support, are unavailable. Although supervisors must support self-directed learning through scaffolding, supervisors indicated they need more guidance in how to do so.[140,141]

Residents report a wide variation in perception regarding the educational competencies of supervisors. A good clinical supervisor embodies several characteristics. While it is important for supervisors to possess strong clinical skills and knowledge in their specialised area, they should not limit their role to simply transmitting information. Instead, they should strive to facilitate learning, for example, by coaching residents and entrusting them with clinical tasks that are within their competence.[142-144] These competencies can be further developed through train-the-trainer sessions. As previously reported, two-way feedback can also support competency development in supervisors.

The relationship between supervisors and residents has a significant impact on learning, but it is often complicated by factors such as high workload, varying levels of motivation for direct supervision, and hierarchical structures. A good working relationship between supervisors and residents is crucial for ensuring optimal patient care and optimal learning in a safe CLE, and it should receive more attention.[145,146]

The need for a safe CLE was also reflected in the perceived inappropriate amount of responsibility and autonomy given to residents. This should be increasingly awarded, but residents reported that the level of responsibility and autonomy was often either too low or too high.[147,148] Although the literature mainly reports too little autonomy at the end of the training, the participants in these focus groups suggested that this imbalance between residents' competency and autonomy level was already present at the beginning of their training, where they are granted too much autonomy.[149] In contrast, they were often granted insufficient autonomy at the end. This imbalance could lead to dangerous situations, as residents may not always seek supervision in critical clinical situations, or they might feel insufficiently challenged and lose their motivation.

Currently, the perceived added value from the ePortfolio in terms of learning and supervision was rather limited. However, ePortfolios have already been shown to have possible benefits for self-directed learning and competency-based learning.[141,150] By providing comprehensive information regarding the residents' current abilities, supervisors could also assign adequate responsibility in clinical practice, which is currently discussed as being a major issue in these focus groups.

This study can offer guidance to all stakeholders involved with WPL to develop a better understanding of how WPL can be optimised to improve the PGME experience. Ultimately, this research has the potential to inform the development of WPL programs that can help to improve the quality of patient care provided by medical professionals. Future studies could focus on confirming the results of this study in a broader, perhaps international setting and exploring strategies for aligning residency training programs to improve quality. Moreover, future studies could explore potential strategies for enhancing collaboration between different residency programs and institutions across Europe to facilitate the sharing of best practices and standardization of training. Further research could also be conducted on the integration of new technologies and innovative teaching methods in residency training, along with their potential enablers and challenges.

6. LIMITATIONS

The strength of this study consists of the in-depth virtual focus groups, allowing iterative responses from participants, with time for reflection as the focus groups evolved over several weeks. When looking at the principles of rigour within qualitative research, we believe the data provides an authentic depiction of WPL in Flanders as this is the first qualitative study to include residents of different specialties on such a large scale in Flanders. Participants covered a wide variety of hospital specialisms, enhancing adequacy of the research. The data were analysed by two researchers in an iterative way using thematic analysis, extracting all different topics. We presented the data analysis as clearly as possible to enhance trustworthiness.[151]

However, the study also has some limitations. First, we could not include all Flemish universities offering a PGME program because of limited time and budget, which might limit the resonance of our research. However, residents from different universities work in the same regional hospitals, and educational programs barely differ between universities. Also,

the number of participants and focus groups ensured diversity. Second, online focus groups were performed due to COVID-19, which might have limited interaction between participants. Nevertheless, a multidisciplinary team of moderators stimulated participants to discuss online. Third, the main researcher is a paediatric resident herself, which may have influenced the development of the initial codes. However, efforts were made to limit this influence, as the other researchers performing independent parallel coding were not involved in medical residencies. Finally, there was a limited participation response which might have been partly caused by COVID-19 having an enormous impact on the workload of hospital staff at the time when the focus groups were executed. This might have led to a situation where only the most motivated residents and supervisors participated. This might have influenced our results. Participating supervisors might have been more interested in medical education and thus not reflect the opinions of the whole group of supervisors, and participating residents might have been more frustrated in their education, thus providing more negative results.

7. CONCLUSION

The study aimed to identify the enablers and challenges for residents and their supervisors involved in training hospital specialists. Focus groups were conducted across different medical specialties and clinical teaching departments. This study highlighted various areas that can inform the further development of WPL programs. Three themes emerged, including dual learning paths, feedback, and learning support. This study can offer guidance to all stakeholders involved with WPL to develop a better understanding of how WPL can be optimised to improve the PGME experience. Further research is needed to confirm these results in a broader international setting and explore strategies for aligning residency training programs.

8. SUPPLEMENTARY FILES

SUPPLEMENTARY FILE 1: QUESTIONS DISCUSSED IN THE FOCUS GROUPS WITH RESIDENTS

Typical day as a resident

- "How does a typical day as a student assistant look in terms of supporting your workplace learning? Additionally, describe the tools you use (e.g., shared folders, email, digital portfolio, school platform, paper folder, etc.)."

Training: residency, ePortfolio

- Have you received any training to work with the ePortfolio? For what purpose? In what way? How much time did it take? Voluntary or mandatory?
- Have you received any training on other matters related to your internships? (e.g., planning or evaluation meetings, formulating goals...)
- Is assistance provided while using the ePortfolio? (e.g., helpdesk)
- What kind of training would you still need (related to your residency)?
- What does the ideal training look like? (method, duration…)

Positive and negative experience during workplace learning

- Which aspects of workplace learning are going well and why? In other words, which elements of a residency allow you to fully develop yourself as a doctor?
- Which aspects of workplace learning are not going as well and why? In other words, which elements of a residency hinder you from fully developing yourself as a doctor in the workplace? There is also room here for general frustrations.

Collaborating

- Is there any training provided in the workplace for interdisciplinary collaboration? If so, what does it look like? If not, what would it look like for you?
- How do the tools available to you as a student (assistant) support your communication with the supervisor? And with the internship mentor? Indicate what is going well and what could be improved.

Evaluation

- How do the tools available to you support your evaluation/assessment? Indicate what is going well and what could be improved.

Video use

- What do you think of the idea of using video or audio recordings in training (for both feedback and support, as well as evaluation, or a combination of both)? What encourages you in this, and what discourages you?

Closure

- We noticed in some responses that goals are formulated at the beginning of an internship. Is this something that happens for everyone? If yes, where do you record them, and is there any follow-up on them? If no, do you feel the need for this?
- If there's anything else you would like to add, feel free to do so below.

SUPPLEMENTARY FILE 2: QUESTIONS DISCUSSED IN THE FOCUS GROUPS WITH SUPERVISORS

Typical day as a supervisor

- How does a typical day as a supervisor look in terms of guiding and training a resident (ASO) in the workplace? Please also describe which tools you might use (e.g., shared folder, email, digital portfolio, school platform, paper folder, etc.).

Training: residency, portfolio

- Have you received training on working with an ePortfolio or on other matters related to guiding students during workplace learning? For what purpose? In what way? How much time did it take? Was it voluntary or mandatory?
- Is assistance provided while using the ePortfolio?
- What additional training could you benefit from?
- What does the ideal training look like for you? (method, duration…)

Positive and negative experiences during workplace learning

- Which aspects of workplace learning during the MSG training are going well and why? In other words, which elements of a rotation/internship allow you to fully take on your role as a supervisor?
- Which aspects of workplace learning are not going as well and why? In other words, which elements of a rotation/internship hinder you from fully taking on your role as a supervisor? There is also room here for general frustrations.

Collaborating

- Is there any training provided in the workplace for interdisciplinary collaboration? If so, what does it look like? If not, what could it look like for you?
- How do the tools available to you as a supervisor support communication with the student? And with the internship mentor? Indicate what is going well and what could be improved.
- How do the tools available to you as a supervisor support the student's self-directed learning? Indicate what is going well and what could be improved.

Evaluation

- How do the tools available to you as a supervisor support the evaluation/assessment of the student? Indicate what is going well and what could be improved.

Video use

- What do you think of the idea of using video or audio recordings in training? What encourages you about this, and what concerns you?

Closure

- If there's anything else you would like to add, feel free to do so below.

Chapter 4: Development of an integrated competency framework for postgraduate paediatric training: a Delphi study

"You only have to be able to [...] within your circle of competence . The size of that circle is not very important; knowing its boundaries, however, is vital."

Warren Buffet

Based on:

Robbrecht, M., Norga, K., Van Winckel, M., Valcke, M., & Embo, M. (2022). Development of an integrated competency framework for postgraduate paediatric training: a Delphi study. *European Journal of Pediatrics*, 1-10.

1. Abstract

Objectives

Competency-based medical education has transformed medical training during the last decades. In Flanders (Belgium), multiple competency frameworks are being used concurrently guiding paediatric postgraduate CBME. This study aimed to merge these frameworks into an integrated competency framework for postgraduate paediatric training.

Methods

In a first phase, these frameworks were scrutinised and merged into one using the Canadian Medical Education Directives for Specialists (CanMEDS) framework as a comprehensive basis. Thereafter, the resulting unified competency framework was validated using a Delphi study with three consecutive rounds.

Results

All competencies (n=95) were scored as relevant in the first round, and twelve competencies were adjusted in the second round. After the third round, all competencies were validated for inclusion.

Discussion

Nevertheless, differences in the setting in which a paediatrician may work make it difficult to apply a general framework, as not all competencies are equally relevant, applicable or suitable for evaluation in every clinical setting. These challenges call for a clear description of the competencies to guide curriculum planning, and to provide a fitting workplace context and learning opportunities. Conclusion: A competency framework for paediatric post-graduate training was developed by combining three existing frameworks, and was validated through a Delphi study. This competency framework can be used in setting the goals for WPL during paediatric training.

2. INTRODUCTION

During the last decades, competency-based medical education (CBME) has driven medical training towards the implementation of competency frameworks to evaluate clinical performance. Different general competency frameworks are available, such as the CanMEDS Framework,[152] the 6 core competencies of ACGME (the Accreditation Council for Graduate Medical Education),[153] and the Scottish Doctor[154]. Specific competency frameworks have also been developed for postgraduate paediatric training, such as the Curriculum for Common Trunk Training in Paediatrics[79] and The Pediatrics Milestones project[155].

CBME offers numerous benefits for a postgraduate paediatric training.[8,62,67,156,157] Its student-centred approach empowers students, facilitates goal-oriented self-directed learning, and stimulates learning within a limited timeframe.[8,158,159] It brings structure to the complex and unstructured clinical environment during workplace learning, the core of postgraduate medical education (PGME).[159,160] By providing explicit evaluation criteria, CBME ensures a more valid and objective assessment[8,67,156-158] as it emphasises accountability and transparency in medical education. CBME facilitates curriculum development[8,67,156] and it presents a utilitarian approach to curriculum planning, advocating that each curricular element should contribute to learner outcomes[62]. Moreover, CBME simplifies and supports the transition between education levels in medical curricula by guaranteeing learning continuity.[157,161] Lastly, the focus on general competencies in CBME contributes to a holistic perspective of the medical profession.[8,67,157]

Currently, different competency frameworks are alternately used in the paediatric training in Flanders (Belgium). First, the competency framework of the European Academy of Paediatrics (EAP), the paediatric division of the European Union of Medical Specialists (UEMS)[79] is very specific for the paediatric discipline. It consists of medical knowledge, technical skills and general competencies. Although this framework is a guideline on how to become a competent paediatrician, it is only used as the basis for summative cognitive assessments and rarely for supporting WPL. Second, the Master of Specialistic Medicine (MSM) has defined four clusters of generic competencies for all specialistic medicine disciplines, which are used for workplace-based assessment and licensure. More specifically, medical expert focuses on the knowledge and technical skills that are inherent to a specific specialty; in the scholar role, the use and conduction of scientific research is underpinned; communicator comprehends all

communication with patients and colleagues, including feedback; and finally the manager role is about working efficiently and professionally. These clusters were extracted and adapted from the original CanMEDS framework, but this is not used in its original form during postgraduate training. In contrast, this original CanMEDS framework has dominantly been adopted in view of undergraduate training in Flanders and even has been validated in this setting.[162] There are some additional roles in the CanMEDS framework that are not included in the MSM framework: the collaborator role overlaps with that of the communicator in the Belgian framework; however, it encompasses more than just communication, extending to working alongside all healthcare professionals, such as in providing high-quality care within the team. The leader role focuses on managing both the care and the team itself. As health advocates, healthcare professionals should work with communities or populations to improve overall health. In the scholar role, one not only engages in scientific research but also continues learning and teaching throughout their entire career.

Thus, the variability in adoption of these different competency frameworks hinders and complicates learning, assessment, and licensure. The adoption of a unified and shared framework could enhance postgraduate paediatric training by ensuring coherence and continuity in evaluating clinical competence. Therefore, the present study aims at reporting the results of a validation study of an integrated competency framework for postgraduate paediatric training, after merging the UEMS, MSM and CanMEDS frameworks.

3. METHODS

CONSTRUCTING THE COMPETENCY FRAMEWORK

We developed a new integrated competency framework by combining 3 existing frameworks: the CanMEDS roles as defined by The Royal College of Physicians and Surgeons of Canada in 2015,[152] the 'Curriculum for common trunk training in paediatrics' as defined by UEMS[79] and the criteria as defined by MSM[78]. The CanMEDS framework was selected as the backbone framework because it is commonly accepted in Flemish undergraduate medical curricula and is already partially adopted in PGME.[13,160,162]

First, the main researcher (MR) linked the general goals and general competencies from the UEMS framework to the CanMEDS roles. Second, the goals and competencies from the UEMS framework were mapped on the key competencies linked to the CanMEDS roles. This version

was reviewed by the research group (ME, MVW, VA, OJ, SVO). In a third step, each specific UEMS competency was linked to an enabling competency of the CanMEDS framework. This helped visualising gaps and overlaps. These 3 steps were repeated for the MSM framework. Next, we looked for options to merge competencies based on keywords reflected in each competency in each of the three frameworks. When matching was impossible, the UEMS or MSM competencies were added to the CanMEDS competencies list. An overview of these different steps can be found in Figure 1. All stages in the procedure were discussed with 2 other researchers (MVW, ME) until consensus was reached. All steps were documented in a Microsoft Excel® document to ensure methodological rigour. Two competencies, referring to discipline-specific knowledge and skills, were enriched with a list containing required specific paediatric knowledge and paediatric skills. In total, 65 competencies from the UEMS framework and 33 competencies from the MSM framework were linked to 89 enabling competencies of the CanMEDS framework. After the final stage in the procedure, researchers agreed on a baseline list of 95 competencies to be validated.

STUDY DESIGN

The baseline framework was validated through an online survey using a Delphi methodology, which is a consensus method[163-165] regularly used to validate competencies[157]. Percentage agreement is common to define consensus in Delphi studies.[166-169] An agreement of 70% has been deemed to reflect a justifiable consensus level.[164] Building on the Likert-type scale scores, this meant that at least 70% of participants scored on either the positive or negative side of the Likert-type scale. Next to the analysis of the quantitative input, the qualitative data was analysed using inductive content analysis.[170] All comments for each competency were open coded, after which they were grouped, put in categories, and meaning was given to these categories. All analyses were performed in Microsoft Excel®.

The survey was piloted by KN and MVW, who are paediatricians, to check clarity and comprehensibility and to estimate time needed for completion. The piloting provided an indication of time required to complete the survey, and ensured clarity, reliability, and feasibility of the Delphi study.[164,171,172]

PARTICIPANTS

Purposive (non-probability) sampling was used to contact experts.[165,172,173] In order to ensure coverage across expertise domains[164,171], participants were recruited from 5 different groups: recently graduated paediatricians, supervisors working as paediatricians in both general and university teaching hospitals in Flanders (Belgium), members of the licensing committee of paediatrics in Belgium, educational experts with experience in medical education affiliated with Flemish Universities, and members of the paediatric section of the UEMS. No exclusion criteria were defined within these categories, as being related to one of our inclusion groups implied sufficient experience with paediatric postgraduate education. We initially aimed at 30 respondents, the ideal balance between decision quality and manageability of the data.[164,171,172] Participants were contacted via e-mail through the organisations to which they were affiliated. Participants were not anonymous to the researcher, but remained anonymous to each other.[164] Informed consent was obtained from each participant.

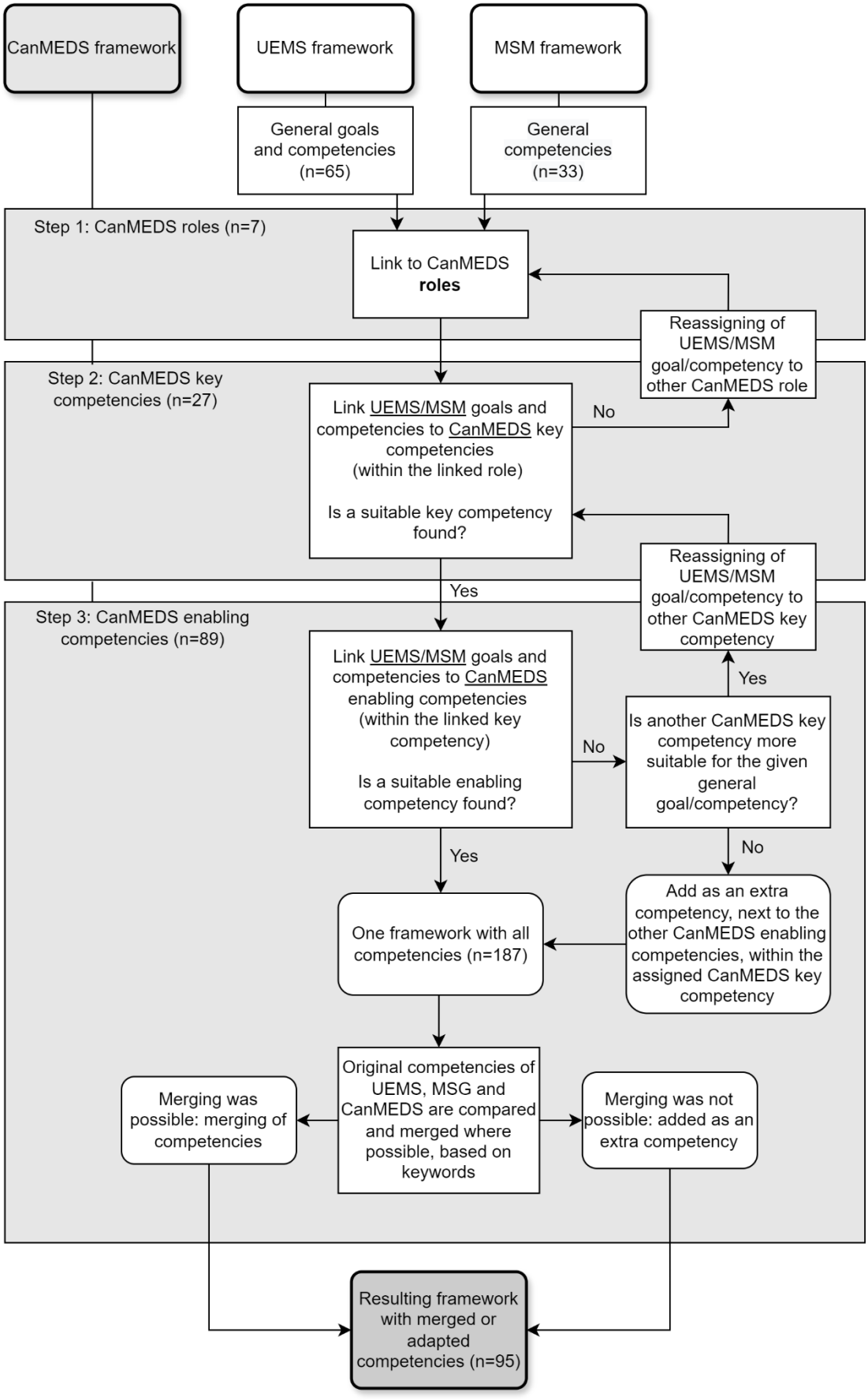


Figure 1: A flowchart of how the competency frameworks were merged.

DELPHI PROCESS

The first Delphi round aimed to reach consensus regarding competence relevance for a graduating general paediatrician. A 6-point Likert-type scale (1 = not at all relevant to 6 = very relevant) was used by respondents, with the possibility to add comments. We used an even-numbered scale to encourage participants to think of a competency as either relevant or not for paediatric training.[174]

After reaching consensus regarding relevance, the focus of the second round was to decide whether the competencies were clearly and appropriately formulated. Participating experts received the survey, supplemented with the level of consensus reached for each competency and the written feedback from round one.[164] They were invited to comment on this input and to judge their relevance[165,175,176] using multiple choice questions. The third round focused on competencies that had not yet reached consensus in the previous rounds. These competencies were again adjusted according to the feedback of experts. Next, participants were asked to judge suitability for inclusion.

DATA COLLECTION

The online tool Qualtrics® was used to collect participants' responses. A personal access link was sent by mail to each participant. Data was collected between August and December 2020 and stored on a secured Ghent University server. The study was conducted in English to prevent translation bias and to facilitate a follow-up study in other countries. However, participants could comment in their language of preference (Dutch, French, or English). To increase response rate, reminders were sent twice during each Delphi round to participants who had not (fully) completed the survey.[172]

4. RESULTS

DEMOGRAPHICS

A total of 101 experts were contacted, of which 21 responded. In the first round, 11 (52.4%) experts completed the questionnaire. In the second round, 4 additional experts from the group of 21 initial responders were included who were not available in round 1. Although they did not participate in the first round, their inclusion was acceptable since the competency list did not change between the first and second round. In round 2, the survey was sent to these 15 participants, of which 13 (86.6%) completed the questionnaire. These 13 remaining experts

all (100%) completed the survey in the third round. Demographics for participants who completed at least one round (n=14) can be found in Table 1.

Topic	Categories	Number
Age	31 - 35 years old	4
	36 - 40 years old	1
	41 - 45 years old	3
	51 - 55 years old	4
	56 - 60 years old	1
	61 - 65 years old	1
Functions*	Recently graduated as a paediatrician (2018 or later)	3
	A member of medical education involved in competency-based education	3
	Supervisor of paediatricians in training affiliated with a Belgian University	9
	A member of the licensing committee for paediatricians	2
	A member of the paediatric section of UEMS	1
University	K.U. Leuven	1
	University of Antwerp	4
	Ghent University	9
Supervised residents per year**	2	2
	5	1
	6 or more	7
	None (not applicable)	2

Table 1. Demographics of participants

* Some participants had multiple functions, making the total amount greater than 14

** This information was not available for all 14 participants

Survey flow

An overview of the survey flow in this Delphi study can be found in Figure 2.

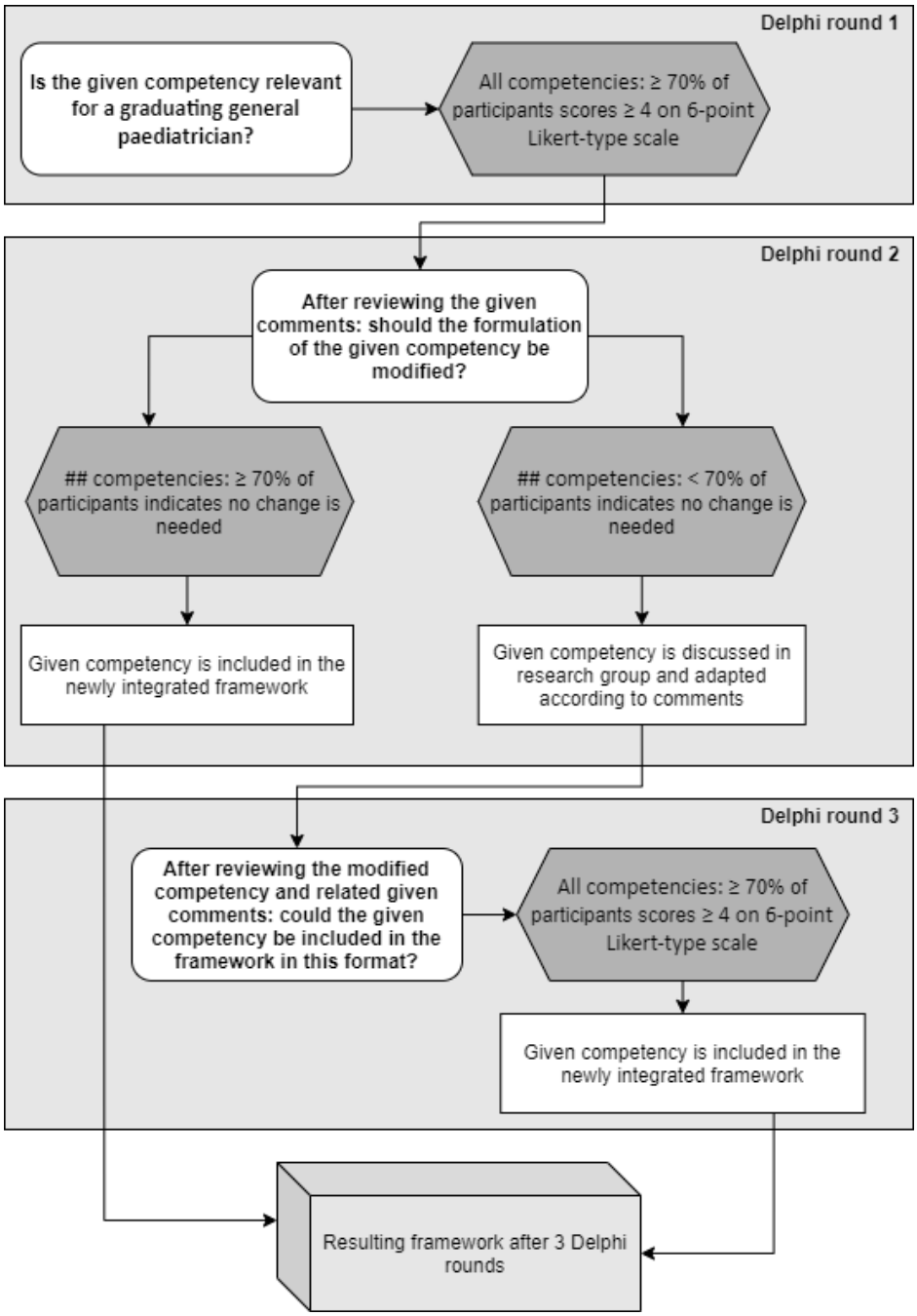


Figure 2: An overview of the survey flow in this Delphi study.

FIRST ROUND

All competencies (n=95) reached a positive 70% consensus as to their relevance. A majority (n = 69) reflected a 100% positive consensus. In total, 84 qualitative comments were given, that could be clustered into 4 areas: more applicable within a different role (n=4); additional information from participants about their own scoring (n=14); adjustments to the formulation (n=26); how the competencies could be acquired in the curriculum during workplace learning (n=40).

SECOND ROUND

Eighty-three competencies could be included as originally stated in round 1, leaving 12 competencies to be reformulated. One competency, 'Perform the paediatric skills as listed in addendum, in a skilful and safe manner', had comments regarding the corresponding skills list, but not regarding the competency itself. Adjustments were made in view of the roles of Medical Expert (n=2), Communicator (n=3), Leader (n=4), Health Advocate (n=2), and Scholar (n=1). An overview of adjustments and adjustment rationales can be found in Table 2. Most suggestions for changes were related to the formulation not being specific enough for the paediatric profession or the wording being too vague. Other changes were related to concerns whether a competency was applicable for every general paediatrician, despite being scored as relevant in the first round. One example was 'Contribute to the work of a research program'; comments questioned whether this is a prerequisite for being a good paediatrician.

	Competency before Delphi study	**Reason for adjustment**	**Adjusted competency after Delphi study**
1	Perform the paediatric skills as listed in addendum, in a skilful and safe manner (ADDENDUM: SAFE PRACTICAL SKILLS*)	Not all skills in Addendum were relevant	Perform the paediatric skills as listed in addendum, in a skilful and safe manner (ADJUSTED ADDENDUM: SAFE PRACTICAL SKILLS*)
2	Identify the limits of one's own competency and act within them	"Act within them" unclear	Identify the limits of one's own competency and act within them **by asking for help when needed**
3	Recognise when the values, biases, or perspectives of patients, physicians, or other healthcare professionals may have an impact on the quality of care, and modify the approach to the patient accordingly	Very broad, unclear	**Consider an adapted approach in order to achieve the highest quality of care** when values, biases or **(cultural)** perspectives of patients, physicians or healthcare professionals **influence healthcare related decisions**
4	Respond to a patient's non-verbal behaviours to enhance communication	Not only patient's, but also parents' or other caregivers' non-verbal behaviours	Respond to a patient's **and a patient's caregivers** non-verbal behaviours to enhance communication

5	Adapt to the unique needs and preferences of each patient and to his or her clinical condition and circumstances, via effective communication and interpersonal skills in an age appropriate manner	Change to "Adjusted to neurodevelopmental maturation"	Adapt to the unique needs and preferences of each patient and to his or her clinical condition and circumstances, via effective communication and interpersonal skills **adjusted to neurodevelopmental maturation**
6	Commit to quality assurance through systemic quality process evaluation and improvement	No consensus regarding relevancy for every paediatrician.	Commit to quality assurance **by taking into account** systemic quality process evaluation and improvement
7	Improve the quality of patient care, by optimising patient safety and maintenance of own expertise while using health informatics	Not only health informatics can be used	Improve the quality of patient care, by optimising patient safety and maintenance of own expertise while using health informatics **and other trustable information sources**
8	Facilitate change in healthcare to enhance services and outcomes	No consensus regarding relevancy for every regional paediatrician.	Facilitate change in their own working environment and practice in order to ameliorate services and outcomes
9	Participate in the organisation of health care and participate in representative functions within health care	No consensus regarding relevancy for every regional paediatrician.	Contribute to the organisation of health care **within their own facility**
10	Use their influence and expertise in working with a community or population to identify the determinants of health that affect children in order to advance child health and well-being within their community	No consensus regarding relevancy for every regional paediatrician.	*Add the option: 'Not applicable'*
11	Identify the effects of local, national and international policies on their work and contribute to a process to improve health in the	No consensus regarding relevancy for every regional paediatrician.	*Add the option: 'Not applicable'*

	community or population they serve		
12	Contribute to the work of a research program (critical literature review, data collection and analysis, reporting research results)	No consensus regarding relevancy for every regional paediatrician.	*Some comments indicated that research is not relevant for every paediatrician. Nevertheless, this competency was scored as relevant in the first round and can therefore not easily be removed.* *A proposal has been made to add 'at least to some degree on individual basis'. However, we believe this makes the competency too open-ended and non-specific enough.* *After careful consideration within our research team, we decided to not adjust this competency for two reasons* *1/ As the post-graduate education requires a thesis for certification, every paediatrician should at least have conducted some kind of research once.* *2/ Although most peripheral paediatricians will not be conducting studies themselves, they might be confronted with the recruitment of participants and perhaps even data collection.* *You can indicate whether further considerations are necessary.*

Table 2: An overview of the adjusted competencies.

Not all 118 qualitative comments suggested to adjust formulation. Seven competencies were perceived as being dependent on the seniority of the resident. Three competencies were perceived as difficult to assess because direct observation influences the situation and thus assessment (n=1), assessment of a competency can be very situational (n=1), and it was

unclear how to assess that particular competency (n=1). Remaining individual comments addressed the need to train cultural competencies and to demonstrate a commitment to discuss mental health in physicians.

THIRD ROUND

The 11 reformulated competencies all reached 100% consensus in the third and final round. The competency related to technical skills list was not reformulated, but as corresponding skills (n=37) were tackled in the comments, the researchers included this list in the third round. However, validation of this list was out of the scope of this study, so no results are available. Nevertheless, it provided additional valuable information for e.g. licensing committees. The final version of the validated competency framework is summarised in Supplementary file 1.

5. DISCUSSION

Three competency frameworks, currently used in Flemish postgraduate paediatric training, were merged into a single framework using a Delphi study. The integration of these different frameworks has been a meaningful exercise, and achieving consensus on this newly integrated framework from different stakeholders acknowledges the usefulness of this integration. By providing an integrated valid framework, the researchers aimed to support uniformity and clarity for clinical educators, professionals, and students in the context of self-directed learning during postgraduate training. Instead of using the former MSM framework, the results of the present study indicate advantages when using the integrated framework. A first advantage is that the new framework encompasses all 7 CanMEDS roles. This ensures continuity throughout the medical training as these 7 CanMEDS roles are already being used during undergraduate training.[162] Furthermore, the integrated framework explicitly reflects a discipline-specific part in terms of knowledge and skills. This differs from the MSM competency framework that is often too broad to guide evaluation and feedback.

The general competencies were supplemented with a discipline-specific knowledge and skills lists. Both general and discipline-specific competencies are needed to become a competent paediatrician. Following this idea helps adopt a holistic curriculum perspective without focusing exclusively on discipline-specific competencies. This additional dimension might also help in supporting specific sub-disciplines within professions or addressing regional

differences in responsibilities of paediatricians. Aside from the discipline specific knowledge and skills lists, the general framework is relevant to other medical specialist disciplines too, although the general competencies might still differ in degree of urgency from one context to another and from discipline to discipline. Nevertheless, the approach reflected in the integrated framework prevents inconsistencies in how competencies are defined and developed.[160] Additionally, the integrated competency framework might support the general curriculum build-up, assessment and feedback practices, and licensure of physicians.[8,67,156-158,161]

Although all competencies were scored as being relevant in the first round, comments surfaced during the second round regarding their relevance for every general paediatrician. Therefore, 2 competencies (see Table 2, competency 10 and 11) were labelled as 'potentially not applicable', pending the working and training settings for residents. Competency-based education focuses on the outcomes needed within the profession,[8,67,156,157,161] but paediatricians can work in many different settings, which might influence the contextual relevance of competencies. Nevertheless, it is important to uphold a standard in view of licensure whereby further profiling may be an additional focus.

The relevance of one competency raised a particular debate. Several participants stressed that active participation in research should not be seen as a prerequisite for a paediatrician. This is in contrast to current training programs, in which a thesis and at least one publication are considered mandatory for graduation. The debate might result from a too "applied" interpretation of competency-based education[62] that only looks at competencies that are considered directly applicable to professional activities.

Although the study aimed to validate the competency framework, caution should be taken to consider it as valid because as reflected in the comments, its implementation in a workplace learning curriculum should be further defined[157] and more input is needed to guide competence assessment[69]. As competencies evolve during training, attention should be paid to defining different levels of required competence for specific situations/settings, e.g. defining a short-term management plan for younger residents versus a long-term management plan for more advanced residents. To guide implementation and assessment in view of a required level of competence, supervisors - who are often not medical educators –

will need a set of quality indicators to guide their training support.[62] Thus, the framework resulted by the Delphi study can be used by curriculum managers to review the curriculum. One possibility is to use the 5 steps of educational design, as described by Sherbino and Frank (2011): 1) needs assessment, 2) learning objectives, 3) instructional methods, 4) learner assessment, and 5) program evaluation.[152] The curriculum review, based on the integrated competency framework and aforementioned steps could improve the quality of learning, assessment, and licensure of the competency framework within postgraduate training.

As professions evolve, the competency framework should also be considered as dynamic. This calls for a future follow-up of the current Delphi study. The starting point can now be the availability of a validated competency framework, based on a variety of views from multiple stakeholders. It offers a shared language and a professional standard. Next validation rounds will therefore be less time demanding and can start from the procedures and strategies outlined in the present Delphi study.

6. LIMITATIONS

Although the researchers aimed at involving 30 participants, only 21 experts indicated initial willingness and only 14 completed at least one Delphi round. This might bias the results as consensus is easier to achieve within a smaller group. Nevertheless, the smaller group reflected multiple expertise fields and can be seen as a representative and qualitative group.[177] As the experts were contacted by email via professional organisations independent from our research network, it is possible that not all experts within our inclusion criteria were reached. Nevertheless, we emphasised the importance of the study to these organisations in view of improving future training programs. On the other hand, the increased workload for the participants because of the COVID-19 pandemic might also have affected their willingness or availability to participate, as time investment is a critical factor in a Delphi study.[165]

New participants were also allowed to participate in the second round. Some might argue this could have affected consistency throughout the three rounds.[164,171] However, we did not change the competency framework between the first and second round. Moreover, the new participants provided additional insightful comments, thus improving the quality of the competency framework.

Mainly experts affiliated with Flemish Universities were included, which might result in some bias due to localization. Nonetheless, since two international frameworks were used, namely the CanMEDS framework and the competency framework as established by the UEMS, the relevance of these frameworks supersedes the local setting. Though, future research should investigate the applicability of the validated framework in other countries.

Lastly, a real discussion between participants was not feasible, and additional questions to clarify comments could not be raised.[163,176] Also, the process itself was time consuming, which might have affected respondents' commitment to the study.

7. CONCLUSION

An integrated competency framework for postgraduate paediatric training was developed by combining three existing frameworks, using the CanMEDS framework as a basis, to provide a holistic view to the profession and supplemented with a discipline-specific knowledge and skills list. This integrated framework was validated through a Delphi study in view of its application in Flanders. Next steps will address curriculum planning in order to ensure competency assessment and development during WPL.

8. SUPPLEMENTARY FILES

SUPPLEMENTARY FILE 1: COMPETENCY FRAMEWORK FOR POST-GRADUATE PAEDIATRIC TRAINING.

The competency framework consists of 7 roles. Each role has corresponding key competencies, which are subdivided in enabling competencies.

Role 1: Medical expert
Key competency 1: *Practise medicine within their defined scope of practice and expertise*
Apply knowledge of both the normal growth and development, as well as common and serious paediatric conditions as listed in addendum* (ADDENDUM: PAEDIATRIC EXPERTISE)
Perform appropriately timed clinical assessments with adequate responsiveness to situations where the wellbeing of the patient is endangered or compromised, and present recommendations in an organised manner
Carry out professional duties in the face of multiple, competing demands
Respond appropriately to the complexity, uncertainty, and ambiguity inherent in medical practice
Acknowledge the vulnerability of babies, children, and adolescents
Ensure the safeguarding of babies, children, and adolescents
Detect signs of problems concerning the wellbeing of babies, children, and adolescents
Key competency 2: *Perform a patient-centred clinical assessment and establish a management plan*
Prioritise issues to be addressed in a patient encounter
Elicit a history and perform a physical examination for the purpose of formulating an appropriate (differential) diagnosis, management, disease prevention and health promotion
Establish goals of care in collaboration with patients and their families, which may include slowing disease progression, treating symptoms, achieving cure, improving function, and palliation
Establish a patient-centred management plan for common and serious paediatric conditions
Key competency 3: *Plan and perform procedures and therapies for the purpose of assessment and/or management*
Order the appropriate investigations for paediatric assessment; interpret their results for the purpose of formulating an appropriate (differential) diagnosis; determine the most appropriate therapies or preventive interventions including the safe prescription of common drugs; all in an evidence-based manner
Obtain and document informed consent, with correct explanation of the risks and benefits of, and the rationale for, a proposed procedure or therapy
Prioritise a procedure or therapy, taking into account clinical urgency and available resources
Perform the paediatric skills as listed in addendum, in a skilful and safe manner (ADDENDUM: SAFE PRACTICAL SKILLS (ADAPTED))
Key competency 4: *Establish plans for ongoing care and, when appropriate, timely consultation*
Implement a patient-centred care plan that supports ongoing care
Follow-up on investigations, response to treatment, and further consultation in the management of acute or chronic illness in children
Key competency 5: Actively contribute, as an individual and as a member of a team providing care, to the continuous improvement of health care quality and patient safety
Recognise harm from healthcare delivery, including patient safety incidents; and display a response to it
Identify the limits of one's own competency and act within them by asking for help when needed

	Deliver the highest quality of care, including the adoption of strategies and the participation in activities that contribute to the promotion of patient safety, and address human and system factors
Role 2: Communicator	
	Key competency 1: *Establish professional therapeutic relationships with patients and their families*
	Communicate correctly and efficiently, using a patient-centred approach that encourages patient trust and autonomy and is characterised by empathy, respect, sensitivity and compassion to establish a positive therapeutic relationship with patients and their families
	Optimise the physical environment for patient comfort, dignity, privacy, engagement, and safety
	Consider an adapted approach in order to achieve the highest quality of care when values, biases or (cultural) perspectives of patients, physicians or healthcare professionals influence healthcare related decisions
	Respond to a patient's and a patient's caregivers non-verbal behaviours to enhance communication
	Manage disagreements and emotionally charged conversations
	Adapt to the unique needs and preferences of each patient and to his or her clinical condition and circumstances, via effective communication and interpersonal skills adjusted to neurodevelopmental maturation
	Key competency 2: *Elicit and synthesise accurate and relevant information, incorporating the perspectives of patients and their families*
	Use patient-centred interviewing skills and active listening skills to effectively elicit and draw together relevant biomedical and psychosocial information and perspectives
	Provide a clear structure for and manage the flow of an entire patient encounter
	Seek and synthesise relevant information and perspectives from other sources, including the patient's family or other healthcare professionals, with patient's consent
	Key competency 3: *Share health care information and plans with patients and their families*
	Communicate relevant understandable oral and written information and explanations to (young) patients and their families that are clear, accurate, and timely, while checking for patient and family understanding
	Communicate bad news to (young) patients and their families in a clear, accurate and respectful manner and provide support in a crisis situation
	Disclose harmful patient safety incidents to patients and their families accurately and appropriately
	Key competency 4: *Engage patients and their families in developing plans that reflect the patient's health care needs and goals*
	Facilitate discussions with patients and their families in a way that is respectful, non-judgmental, and culturally safe on issues, problems and plans to develop a shared plan of care
	Support patients and their families to identify, access, and make use of information and communication technologies to support their care and manage their health
	Use communication skills and strategies that help patients and their families make informed decisions regarding their health
	Key competency 5: *Document and share written and electronic information about the medical encounter to optimise clinical decision-making, patient safety, confidentiality, and privacy*
	Document clinical encounters in medical (hospital) records and legal documents in an accurate, comprehensive, complete, timely, accessible manner, in compliance with regulatory and legal requirements
	Communicate effectively by clear record-keeping and report-writing using a written health record, electronic medical record, or other digital technology

Share information with patients and others in a manner that respects patient privacy, confidentiality, and autonomy and enhances understanding and ability to consent
Role 3: Collaborator
Key competency 1: *Work effectively with physicians and other colleagues in the healthcare professions*
Demonstrate efficient and effective communication and interpersonal skills for the establishment of positive relationships with physicians and other colleagues in the healthcare professions that support relationship-centred collaborative care
Negotiate overlapping and shared responsibilities with physicians and other colleagues in the health care professions in episodic and ongoing care
Participate appropriately in a professional healthcare team, including the engagement in respectful shared decision-making, to achieve optimal patient care
Key competency 2: *Work with physicians and other colleagues in the health care professions to promote understanding, manage differences, and resolve conflicts*
Show professional respect for the views and contributions of colleagues in a range of roles in paediatric practice.
Implement strategies to promote understanding, manage differences, and resolve conflicts in a manner that supports a collaborative culture
Key competency 3: *Hand over the care of a patient to another health care professional to facilitate continuity of safe patient care*
Determine when and to whom additional advice, opinion, help, support or supervision should be asked for and care should be transferred to another physician or healthcare professional
Demonstrate safe handover, referral and discharge planning of care; using both verbal and written communication during a patient transition to a different health care professional, setting or stage of care
Role 4: Leader
Key competency 1: *Contribute to the improvement of health care delivery in teams, organizations, and systems*
Commit to quality assurance by taking into account systemic quality process evaluation and improvement
Contribute to the organisation of health care within their own facility
Contribute to a culture that promotes patient safety
Analyse patient safety incidents to enhance systems of care
Improve the quality of patient care, by optimising patient safety and maintenance of own expertise while using health informatics and other trustable information sources
Key competency 2: *Engage in the stewardship of health care resources*
Allocate healthcare resources for optimal patient care
Apply evidence and management processes to achieve cost-appropriate care
Key competency 3: *Demonstrate leadership in professional practice*
Demonstrate leadership skills by effectively assign, delegate and follow-up on tasks to enhance healthcare
Manage stressful situations with effective responses to challenge, complexity and stress in paediatrics
Facilitate change in their own working environment and practice in order to ameliorate services and outcomes
Key competency 4: *Manage career planning, finances, and health human resources in a practice*
Set priorities and maintain effective time management skills to integrate practice and personal life
Manage a career and a practice
Implement processes to ensure personal practice improvement

Role 5: Health advocate
Key competency 1: *Respond to an individual patient's health needs by advocating with the patient within and beyond the clinical environment*
Work with patients to address determinants of health that affect them and their access to needed health services or resources
Use their influence and expertise to increase opportunities for patients and their families to adopt healthy behaviours, and advance health as well as the well-being of individual patients and their families
Incorporate disease prevention, health promotion, and health surveillance into interactions with individual patients
Key competency 2: *Respond to the needs of the communities or populations they serve by advocating with them for system-level change in a socially accountable manner*
Use their influence and expertise in working with a community or population to identify the determinants of health that affect children in order to advance child health and well-being within their community (if applicable)
Improve clinical practice by applying a process of continuous quality improvement to disease prevention, health promotion, public health issues and health surveillance activities
Identify the effects of local, national and international policies on their work and contribute to a process to improve health in the community or population they serve (if applicable)
Role 6: Scholar
Key competency 1: *Engage in the continuous enhancement of their professional activities through ongoing learning*
Make a lifelong commitment to learning by accepting responsibility for developing, implementing, monitoring and revising a personal continuing education strategy to enhance professional practice
Regularly reflect on and assess their performance using various internal and external data sources to identify opportunities for learning and improvement by holding a positive approach to receiving mentoring and educational supervision
Engage in collaborative learning to continuously improve personal practice and contribute to collective improvements in practice
Key competency 2: *Teach students, residents, the public, and other health care professionals*
Demonstrate effective teaching, with the recognition of the influence of role-modelling and the impact of the formal, informal, and hidden curriculum on learners
Promote a safe learning environment
Ensure patient safety is maintained when learners are involved
Plan and deliver a learning activity to students, colleagues and other healthcare professionals
Provide feedback to enhance learning and performance
Assess and evaluate learners, teachers, and programs in an educationally appropriate manner
Key competency 3: *Integrate best available evidence into practice*
Generate focused questions that address practice uncertainty and knowledge gaps in clinical and other professional encounters
Identify, select and navigate pre-appraised research resources such as publications and electronic literature databases
Critically evaluate the integrity, reliability, and applicability of health related research and literature
Integrate evidence into decision-making in their practice
Key competency 4: *Contribute to the creation and dissemination of knowledge and practices applicable to health*
Demonstrate an understanding of the scientific principles of research and scholarly inquiry and the role of research evidence in healthcare

	Recognise special issues pertaining to children participating in research, and identify ethical principles for research and incorporate them into obtaining informed consent, considering potential harms and benefits, and considering vulnerable populations
	Contribute to the work of a research program (critical literature review, data collection and analysis, reporting research results)
	Pose questions amenable to scholarly inquiry and select appropriate methods to address them
	Summarise and communicate to professional and lay audiences, including patients and their families, the findings of relevant research and scholarly inquiry
Role 7: Professional	
	Key competency 1: *Demonstrate a commitment to patients by applying best practices and adhering to high ethical standards*
	Exhibit appropriate professional behaviours and relationships in all aspects of practice, demonstrating honesty, integrity, humility, commitment, compassion, respect, altruism, respect for diversity, and maintenance of confidentiality.
	Demonstrate a commitment to excellence in all aspects of practice
	Demonstrate reliability and responsibility in continuity of care by ensuring their accessibility to colleagues, patients and their families
	Demonstrate ethical personal and professional practice, including recognizing and responding to ethical issues encountered in practice and showing sensitivity and responsiveness to a diverse patient population
	Manage conflicts of interest while following the principle that all decisions are to be made in the best interests of the patient
	Exhibit professional behaviours in the use of technology-enabled communication
	Key competency 2: *Demonstrate a commitment to society by recognizing and responding to societal expectations in health care*
	Demonstrate accountability to patients, society, and the profession by responding to societal expectations of physicians
	Key competency 3: *Demonstrate a commitment to the profession by adhering to standards and participating in physician-led regulation*
	Fulfil and adhere to the professional and ethical codes, standards of practice, laws governing practice and comply with all legal and moral obligations for reporting disease and potential or real abuse/neglect
	Recognise and respond to unprofessional and unethical behaviours in physicians and other colleagues in the healthcare professions
	Participate in peer assessment and standard-setting
	Key competency 4: *Demonstrate a commitment to physician health and well-being to foster optimal patient care*
	Exhibit self-awareness and a responsible approach to the health, stress, well-being and professional performance of their own
	Manage personal and professional demands for a sustainable practice throughout the physician life cycle, and to manage personal demands in their accessibility to colleagues, patients and their families
	Maintain the health of the team they work with and promote a culture that recognises, supports and responds effectively to colleagues in need

Chapter 5: What is the learning effect of video review in postgraduate medical education: A systematic review

"We do not learn from experience… we learn from reflecting on experience."

John Dewey

Under peer review

1. Abstract

Background

Video review is a feasible, commonly used learning tool, but current literature lacks a comprehensive review of its impact on learning in postgraduate medical education. This systematic review aims at examining the learning effect of video review of resident performance in clinical practice during postgraduate medical education.

Methods

A systematic literature search was conducted from May 2023 to July 2023 with an update on 12/12/2023. Databases of MEDLINE (Pubmed), Web of Science, Embase and ERIC (through Webquest) were searched. Eligible articles had to describe the learning effects of video review in clinical practice in PGME. The videos had to be actively recorded in a setting where a camera was not normally used for standard patient care. The investigated effect needed to be classified at least as a Kirkpatrick level 2. We iteratively developed a standardised data extraction form to extract study characteristics. The methodological quality of the individual studies was assessed using the Medical Education Research Quality Instrument.

Results

Out of 9323 records after deduplication, 11 studies were included. The designs were randomised controlled trials (n=4) and single-group pre-test post-test trials (n=7). The studies had outcomes related to knowledge and skills (n=5), resident behaviours (n=5) and patient outcomes (n=1). All studies reported outcomes regarding learning effect.

Conclusions

Video review appears to have a positive impact on residents' learning outcomes in postgraduate medical education. However, it is mostly not tailored to the specific learning needs of residents, and there is a lack of information regarding its optimal integration with other learning methods and within distinct clinical contexts. The heterogeneity observed among the included studies makes it challenging to formulate clear recommendations in the use of video.

2. INTRODUCTION

Postgraduate medical education (PGME) historically relied on the assumption that participation in clinical practice, under experienced supervision, was sufficient for resident training. With medical practice becoming more complex, there is a growing societal demand for medical education to be accountable for delivering competent doctors.[10,178] This shift has prompted research into intentional and structured learning processes taking place in clinical practice.[7,41] Emphasis is now placed on reflection, feedback and dedicating time to foster deep learning during workplace learning (WPL).[36,179,180] Additionally, recognising residents as adults with specific learning needs, there is a focus on self-regulated learning where goal setting shapes their educational journey.[181] In the dynamic nature of PGME, achieving medical competence demands innovative, evidence-based high-quality educational methodologies, with technology playing an important role in this evolution.[182]

The introduction of video recordings over half a century ago has provided opportunities for residents and their supervisors to optimise the learning experience with technology. During clinical work, where patient care often takes priority over learning, video review can offer valuable support. Video review, involving the analysis of residents' clinical practices through recorded footage, fosters reflection and feedback by enabling both residents and supervisors to revisit events exactly as they unfolded.[102,103] During video review, residents can focus solely on reflection. The cognitive load theory suggests that minimising mental effort enhances deeper learning due to human cognitive system limitations.[183] By reviewing video, the mental effort associated with clinical care is eliminated. Supervisors benefit from the same lowered cognitive load when reviewing, potentially leading to more extensive and specific feedback.[102,103]

Video review is a feasible, commonly used tool and has already been investigated in different contexts.[100,106,109-111,184-186] However, transferring research results to all clinical contexts in PGME might not be recommended for several reasons. The use of video in simulation practices[185] is different from clinical learning, as the simulation environment is not entirely mimicable to the clinical learning environment (CLE). The roles of undergraduate medical students[100] differ from the roles PGME residents have, where increased responsibilities in clinical care require more specific and deeper learning. In surgical settings,[109-111,186] residents are more familiar with camera use, but integrating it into non-routine clinical care may evoke

a Hawthorne effect: residents could alter their behaviour because they are aware of being recorded[187]. As we are uncertain about the various effects on the learning process of residents, we cannot automatically apply all the insights and recommendations from video use in these contexts to the utilisation of video review in PGME. This indicates a need for a review of the results in the specific context of video use for resident training in the clinical, non-simulation setting where cameras are not commonly used. This review allows for meaningful comparisons and the establishment of comprehensive evidence and guidelines for video use in PGME.

Conceptualising the learning effect of an educational intervention (e.g. video) in medical education is difficult. The model of Kirkpatrick,[188] commonly applied in adapted forms for medical education reviews,[189] classifies learning outcomes and assesses the effectiveness of interventions. Much of the literature on video use in PGME predominantly evaluates participant experiences, also known as Kirkpatrick level 1. However, it lacks insights into participants' enhancements in knowledge and skills (level 2), changes in behaviour (level 3), or the impact on patient and healthcare outcomes (level 4). Therefore, this systematic review focused on learning effects beyond opinions of participants (level 1), namely Kirkpatrick levels 2 to 4. The following research question was established: what is the learning effect of using video review of resident performance in clinical practice during PGME?

3. METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA) guidelines.[190] The checklist is provided in Supplementary file 1. The protocol was registered on the PROSPERO International Prospective Register of Systematic Reviews (CRD42023442318). The primary outcome measure was the learning effect of video review in clinical practice in PGME settings, secondary outcomes were participants' perceptions of being recorded and costs (temporal and monetary).

SEARCH STRATEGY

A systematic literature search was conducted from May 2023 to July 2023. Scoping searches were conducted to refine the search strategy, a research librarian was consulted for advice, and an expert in the field of medical education was contacted to ensure that no relevant

articles were omitted. The search strategy combined terms related to 'resident', 'video', and 'learning'. It involved searching titles, abstracts, and keywords by combining different search terms and applying database-specific standardised keywords where possible. Databases of MEDLINE (Pubmed), Web of Science, Embase and ERIC (through Webquest) were searched. The complete search strategy for each database can be found in Supplementary file 2. References of eligible articles were manually reviewed. Finally, we updated the database search on 12/12/2023.

Eligibility criteria

For articles to be eligible, it was necessary to describe the learning effects of video review in clinical practice in PGME. This included recordings of both general practitioners (GPs) and medical specialists in training. The videos had to be actively recorded in a setting where a camera was not normally used for standard patient care. The investigated effect needed to be classified as Kirkpatrick levels 2 to 4.[189] Included studies were in English or Dutch.

Studies on video use with simulation, animals, summative feedback or evaluation, endoscopy, classroom teaching, or prerecorded educational videos were excluded. Conference papers and letters to the editor were not considered for inclusion due to their limited provision of sufficient detail for adequate data extraction and quality assessment.

Study selection

Duplicate records were removed in Endnote (Clarivate™, Philadelphia, PA, USA) using the approach described by Bramer et al.[191] The screening process was conducted in Rayyan AI assisted Systematic Literature Review web application (Rayyan Systems, Inc; Cambridge MA, USA).[192] First, one reviewer (MR) conducted an initial screening of all titles and abstracts, while a group of three reviewers (MVW, ME, HD) independently performed one-third each of the second screening. Any disagreements regarding eligibility were resolved through discussions between two reviewers (MR, MVW, ME, HD). The remaining full texts were then independently screened by two reviewers for inclusion (MR, MVW).

Data collection

We iteratively developed a standardised data extraction form to extract study characteristics. One reviewer (MR) performed the initial data extraction for all included articles and a second

reviewer (MVW) reviewed data for completeness. All outcomes and variables for which data were extracted are available in Supplementary file 3.

Quality assessment

The methodological quality of the individual studies was assessed using the Medical Education Research Quality Instrument (MERSQI), which has been demonstrated as valid and reliable in the assessment of medical education research.[193,194] Two reviewers (MR, MVW) performed the initial quality appraisal for all included articles and disagreements were resolved by discussion.

Data extraction and analysis

The findings of each included study were summarised in tables, which included the main characteristics of the study and the results in natural units as reported by the investigators. In accordance with the data presented in Supplementary file 4, a narrative synthesis was formulated.

4. Results

Study selection

A total of 15.864 studies were retrieved, of which 6541 were removed as duplicates. The remaining 9323 records were screened based on title and abstract, resulting in 133 records for full-text screening. Thirteen articles were excluded because the full-texts were not retrievable. Another 109 studies were excluded as they did not meet the eligibility criteria. Ultimately 11 studies were included. The complete flowchart is available in Figure 1.

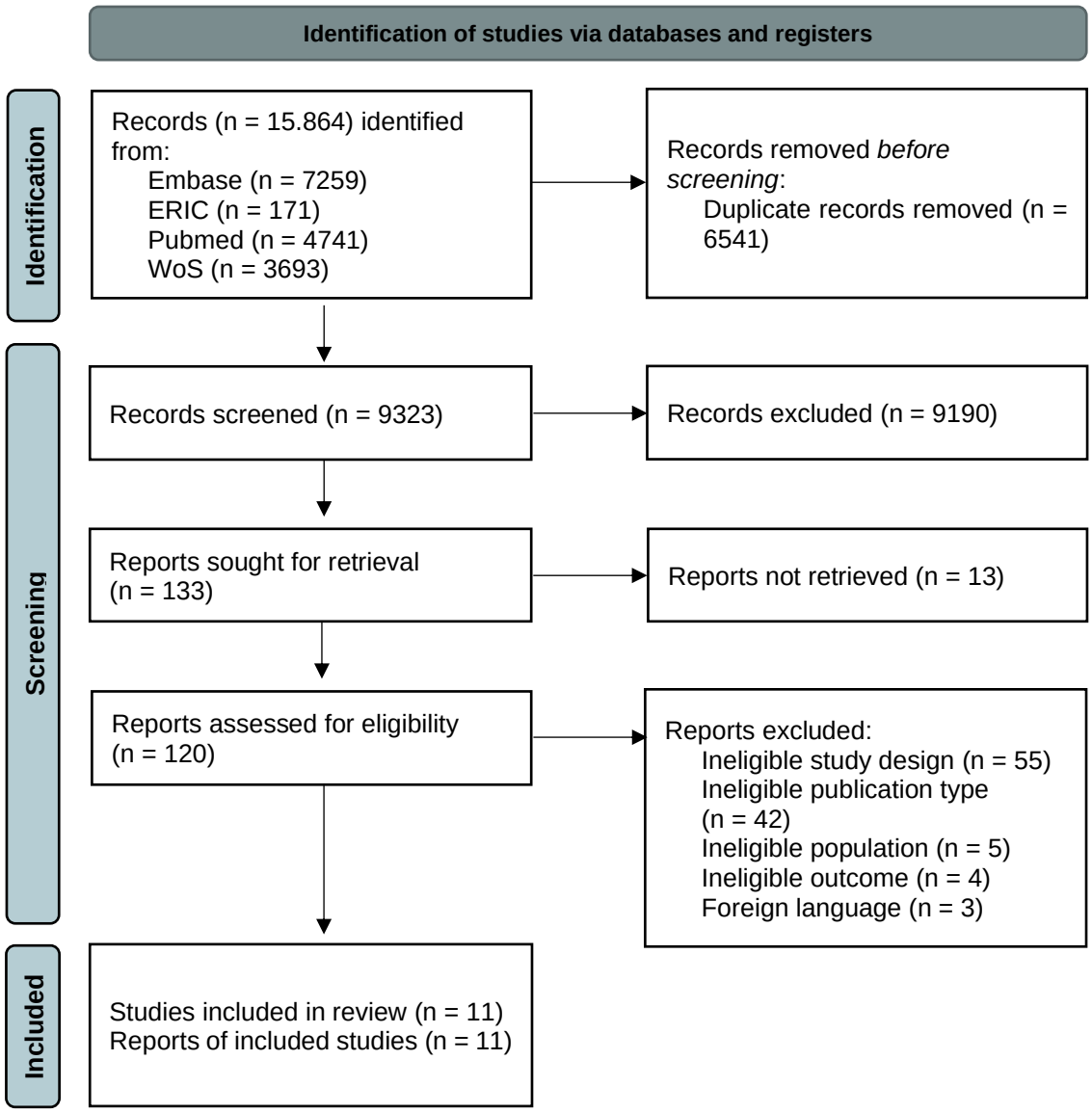


Figure 1. PRISMA flowchart of study selection.

STUDY CHARACTERISTICS

The details of the included studies (n=11) are presented in Supplementary file 4. Study designs were either randomised controlled trials (RCT) (n=4) or single-group pre-test post-tests (n=7). Only 1 RCT specified the sequence generation. Study duration was specified in six studies and varied between 30 days and 15 months, with a median of three months. Study locations included the United States (n=6), United Kingdom (n=2), France (n=1), the Netherlands (n=1) and Australia (n=1). Studies included postgraduate residents from various medical specialist disciplines: surgical residents (n=4), anaesthesiology residents (n=2), GPs in training (n=2), otolaryngology (n=1), emergency medicine (n=1), dermatology and plastic surgery residents

(n=1). Post-graduate years ranged from the first to the last year. Participant numbers varied from 5 to 44 residents (median: 16). Video recording decisions were made by the study investigators during specific procedures (n=6) or within selected time periods (n=3), with no instances of resident-initiated recording. The remaining studies lacked information regarding video recording decisions timing criteria. Studies often combined self-reflection or self-assessment from the resident with feedback from a supervisor (n=9), while one study focused solely on self-reflection and another on external feedback. The number of videos recorded per participant ranged from 1 to 20 (median: 1.5). Residents reviewed recordings once (n=7), twice (n=2) or 1 to 3 times, depending on their participation in video-feedback sessions. The time period between recording and reviewing was not specified (n=5), between 0 to 43 days (n=2), or between 1 and 3 (n=4).

PRIMARY OUTCOME: LEARNING EFFECT

It was not possible to calculate summary measures or average effects across studies due to the diversity of intervention designs, study methods, and heterogeneity in outcome measures.

KIRKPATRICK LEVEL 2

Four studies had outcomes related to knowledge and skills. Isreb et al.[195] compared the total scores of 10 surgical residents on a procedure-based assessment form post-operation and post-video review, assessing 6 general assessment domains. Only two out of 10 video reviews resulted in an additional point on a 10-point scale. Goldberg et al.[196] recorded GPs in training using a psychiatric screening questionnaire. Experienced GPs and GPs in training completed rating scale scores before and after video review. Significant differences in favour of video review were observed when comparing pre- and post-test scores between the index and control groups. Mazer et al.[197] compared evaluation questionnaires from surgical residents and supervisors, addressing the interaction between them and compared the content between discussions in the operating room and discussions during the video review. They did not find differences in the results of the evaluation questionnaires. The transcript analysis of the discussions showed some significant differences: the discussion of anatomy and steps of the procedure were discussed more intra-operatively while discussion of intraoperative decision making was discussed more during video-based coaching. Hu et al.[198] conducted a follow-up study based on the transcriptions of Mazer et al.[197] Additional insights included the

presence of more teaching points per unit time, residents and supervisors being more focused on resident education providing and increased depth of teaching in the video sessions.

KIRKPATRICK LEVEL 3

Six studies reported learning effects on behaviour. Hays et al.[199] investigated three self-assessment scores and one feedback score per video for GPs in training, measured over two videos with 10 to 13 weeks in between. They found that the mean of all scores, including communication, history taking, and diagnostic and management skills, improved after the second video. Kava et al.[200] studied leadership management of emergency medicine residents during resuscitations. The video review group, engaging in self-reflection after the first recording, exhibited improved scores and thus leadership in the second resuscitation, whereas the control group did not. Parker et al.[201] measured medication prescribing errors in the period before and after video feedback and self-assessment sessions with surgical residents, revealing a significant decrease of errors post-video review. Wouda et al.[102] included dermatology and plastic surgery residents engaging in video communication assessment and feedback (video-CAF) sessions at different time points. After video-CAF sessions, following results were found: 1) an increased number of learning objectives; 2) a significant increase in one out of four subcompetency scores in patient education rating scale scores; 3) but patient surveys showing no difference in their opinions about residents. Birnbach et al.[202] combined two rating scale scores evaluating the technical performances of anaesthesia residents on three different time points. These scores, graded by assessors at three time points, consistently demonstrated a positive and significant score improvement in the video review group compared to the non-video review group. Son et al.[203] had otolaryngology residents to review 10 videos with feedback from patients and faculty regarding communication skills. On a second occasion, 10 additional videos were recorded and rated. Patient feedback significantly improved, and faculty feedback showed a significant increase in scores for 11/14 questions after the video intervention.

KIRKPATRICK LEVEL 4

Only one study reported on the impact on patient outcomes. Guerrier et al.[204], partly evaluated the learning effect on Kirkpatrick level 4. They investigated anaesthesia residents, recorded twice with a 7-day gap performing an anaesthetic bloc. The video review group engaged in self-reflection and feedback, and showed a greater increase in "akinesia score",

greater decrease in duration of procedure and lesser need for supplemental injection on day five compared to the non-video review group. All of these differences were significant.

SECONDARY OUTCOMES

Four studies addressed perceptions of being recorded. Parker et al.[201] found that although residents were conscious of being recorded, it did not hinder them. In the study of Birnbach et al.[202], residents initially felt uncomfortable being recorded, but this feeling disappeared by the end. The reviewing of the recordings motivated them for improving their technique. Two studies[195,199] stated that residents found review of video recordings beneficial for their learning. In the study of Isreb et al.[195], residents even favoured video review feedback over verbal feedback using a standardised assessment form.

Only five studies gave an indication of the temporal cost by describing the duration of review sessions, which showed substantiate time effort: 30-45 minutes[201], 16-90 minutes with a mean of 44 minutes[195], approximately 45 minutes[196], 60-90 minutes[102], and 90 minutes[199]. Only one study described monetary costs by specifying the cost of the recording equipment, which was $1500[203].

QUALITY ASSESSMENT OF THE INCLUDED STUDIES

The quality of the studies was assessed using the MERSQI[193], which provided a score between five and 18. The mean total MERSQI score of studies in this review was 11.53 (range 7-13.5). A complete overview is given in Table 1.

Citation	Score calculation		
	Sum (items 1-19)	Total possible score	Summary score (/18)
Isreb, et al. [195]	7	18	**7**
Hays [199]	10	18	**10**
Wouda and van de Wiel [102]	11,5	18	**11,5**
Son, et al. [203]	11,5	18	**11,5**
Birnbach, et al. [202]	12	18	**12**
Guerrier, et al. [204]	12	18	**12**
Mazer, et al. [197]	10	15	**12**
Hu, et al. [198]	10	15	**12**
Kava, et al. [200]	11,5	17	**12,2**
Parker, et al. [201]	11	15	**13,2**
Goldberg, et al. [196]	13,5	18	**13,5**

Table 1: The sum, total possible score and summary score of the included studies were evaluated using the MERSQI instrument.[193]

5. Discussion

This systematic review explores the learning effect of incorporating video review into the education of residents in PGME. It focuses on clinical settings where camera use is not a regular component of daily clinical care. The results indicate positive learning effects associated with video review, with 8 studies reporting significant results.[102,196-198,201-204] Positive effects are reported for levels 2 to 4 of Kirkpatrick's model for evaluation. These findings align with studies in other contexts, suggesting favourable outcomes for using video review with residents.[100,103,109-111,186]

While residents are expected to be self-regulated learners[181], in all studies the investigators, and not the residents, determined video recording parameters, revealing a gap in aligning video practices with personalised learning trajectories. Wouda et al.[102] measured residents' learning objectives; however, it is unclear if the video recordings were aligned with the

content of these objectives. More tailored educational practices could be achieved through fostering self-regulated learning, stimulating reflective practices and providing more helpful goal-based feedback.[179-181] Despite this absence, residents expressed positive experiences, finding video reviews useful, as indicated by other studies.[106,184]

The specific value of video review for the purpose of feedback and formative assessment, and how it can be optimally integrated into resident education, remains complicated to tackle because of different reasons. First, only 11 studies could be included in this review despite more than half a century of video use. This seems a small number given the frequent use of video in the training of GPs and medical specialists.[102,106,205] The great variability in study design complicates this even further. Second, few studies[195,198,200] delve into theoretical educational frameworks, overlooking factors influencing the learning effect and lacking nuanced insights into how video impacted learning. Integrating and evaluating theoretical insights from various medical and non-medical contexts, such as those found in teacher training[206] or sports[207], may help bridge the existing gap. Third, exploring the interplay between video review and other educational strategies is crucial. Most studies combined video review with feedback sessions or coaching,[102,195-197,199,201,202,204] complicating the assessment of video's isolated impact and impeding formulation of recommendations for effective use of video review in resident education. The study of Mazer[197] demonstrated that certain factual topics (e.g. discussion of anatomy) are extensively discussed intraoperatively, while clinical reasoning predominates in video review session with supervisors. This implies potential complementarity between video and other educational interventions.

The studies demonstrate strengths and weaknesses. Strengths include that 10 out of 11 studies measured objective data. Weaknesses were exclusively single-institutional studies, only three reporting a response rate, and many omitting information on evaluation instrument validity. Additionally, most studies employed a single-group pretest-posttest design, potentially introducing bias due to the inherent learning effect over time. Although Isreb et al.[195] discussed the Hawthorne effect in their introduction, only Son et al.[203] explored its implications in their study context. Lastly, only one study investigated outcomes at the Kirkpatrick level 4 in their analysis. This is a challenging outcome to measure, but considering that improved patient and healthcare outcomes are the main goal of optimising residents'

training, it deserves more attention and more studies should orient their investigations toward this aspect.

6. LIMITATIONS

This review is subject to several limitations that should be considered when interpreting the findings. Firstly, only 11 studies meet the inclusion criteria with four RCTs, underscoring the restricted pool of available studies. The scarcity of RCTs may affect the robustness of the evidence base. Secondly, the heterogeneity observed among the included studies poses a challenge in synthesising results due to variations in study design, interventions, and outcome measures. This diversity introduces complexities in drawing overarching conclusions. Lastly, we chose to confine the scope of this review to specific clinical situations, namely those where a camera is not routinely incorporated into daily clinical care. This restriction may limit the applicability of the findings to various, heterogeneous clinical contexts.

7. CONCLUSIONS

In conclusion, using video review in clinical practice where cameras are not routinely integrated, appears to have a positive learning effect on residents. However, studies are scarce and heterogenous in design, complicating the formulation of clear recommendations for video review in PGME. There is insufficient information regarding the optimal integration with other learning methods and in diverse clinical contexts. Additionally, the current approach lacks customisation to residents' learning needs. Future studies should not only investigate the impact of video on (self-regulated) learning at different Kirkpatrick levels but also delve into the mechanisms through which it enhances learning. This research is essential for developing recommendations aimed at maximising video review's learning potential in PGME.

8. SUPPLEMENTARY FILES

SUPPLEMENTARY FILE 1: PRISMA CHECKLIST

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 75
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 76
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 77-78
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 78
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 79
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 78-79
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 92-95
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 79
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 79-80
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 96-97
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 96-97
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools	Page 80

Section and Topic	Item #	Checklist item	Location where item is reported
		used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 80
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 80
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 80
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 80-81
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	N/A
Study characteristics	17	Cite each included study and present its characteristics.	Page 84-86
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 88
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Supplementary file 4

Section and Topic	Item #	Checklist item	Location where item is reported
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 84-87
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 87-89
	23b	Discuss any limitations of the evidence included in the review.	Page 87-89
	23c	Discuss any limitations of the review processes used.	Page 89
	23d	Discuss implications of the results for practice, policy, and future research.	Page 89
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 80
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 80
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 4
Competing interests	26	Declare any competing interests of review authors.	N/A
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

SUPPLEMENTARY FILE 2: SEARCH STRATEGIES PER DATABASE

EMBASE

#1	"'resident'/exp OR 'medical registrar'/exp OR 'postgraduate student'/exp OR 'postgraduate education'/exp"
#2	"'resident':ti,ab,kw OR 'residents':ti,ab,kw OR 'residency':ti,ab,kw OR 'residencies':ti,ab,kw OR 'registrar*':ti,ab,kw OR 'specialist train*':ti,ab,kw OR 'specialist learn*':ti,ab,kw OR 'specialist educat*':ti,ab,kw OR 'postgraduate train*':ti,ab,kw OR 'postgraduate learn*':ti,ab,kw OR 'postgraduate educ*':ti,ab,kw OR 'gp trainee*':ti,ab,kw"
#3	"#1 OR #2"
#4	"'videotape'/exp OR 'videorecording'/exp OR 'audiovisual recording'/exp"
#5	"'video*':ti,ab,kw OR 'filming':ti,ab,kw OR 'recording*':ti,ab,kw OR 'taping':ti,ab,kw"
#6	"#4 OR #5"
#7	"'constructive feedback'/exp OR 'learning'/exp OR 'teaching'/exp OR 'education'/exp OR 'medical education'/exp"
#8	"'feedback':ti,ab,kw OR 'learn*':ti,ab,kw OR 'training':ti,ab,kw OR 'self-reflection':ti,ab,kw OR 'self-modeling':ti,ab,kw OR 'self-review':ti,ab,kw OR 'coaching':ti,ab,kw OR 'debriefing':ti,ab,kw OR 'teaching':ti,ab,kw OR 'education*':ti,ab,kw OR (performance NEAR/4 improv*) OR (skill NEAR/4 improv*) OR (performance NEAR/4 enhanc*) OR (skill NEAR/4 enhanc*) OR (performance NEAR/4 acqui*) OR (skill NEAR/4 acqui*)"
#9	"#7 OR #8"
#10	"#3 AND #6 AND #9"

PUBMED

#1	"Education, Medical, Graduate"[Mesh]
#2	"resident" [Title/Abstract] OR "residents" [Title/Abstract] OR "residency" [Title/Abstract] OR "residencies" [Title/Abstract] OR "registrar*" [Title/Abstract] OR "specialist train*" [Title/Abstract] OR "specialist learn*" [Title/Abstract] OR "specialist educat*" [Title/Abstract] OR "postgraduate train*" [Title/Abstract] OR "postgraduate learn*" [Title/Abstract] OR "postgraduate educat*" [Title/Abstract] OR "GP trainee*" [Title/Abstract]
#3	#1 or #2
#4	"Videotape Recording"[Mesh] or "Video Recording"[Mesh]
#5	"video*" [Title/Abstract] or "filming" [Title/Abstract] or "recording*" [Title/Abstract] or "taping" [Title/Abstract]
#6	#4 or #5
#7	"Formative Feedback"[Mesh] or "Learning"[Mesh] or "Education"[Mesh] or "Mentoring"[Mesh] or "Teaching"[Mesh]
#8	"Feedback" [Title/Abstract] or "Learn*" [Title/Abstract] or "Training" [Title/Abstract] or "Self-reflection" [Title/Abstract] or "Self-modeling" [Title/Abstract] or "Self-review" [Title/Abstract] or "Coaching" [Title/Abstract] or "debriefing" [Title/Abstract] or "teaching" [Title/Abstract] or "Education*" [Title/Abstract] or performance NEAR/4 improv* [Title/Abstract] or skill NEAR/4 improv* [Title/Abstract] or performance NEAR/4 enhanc* [Title/Abstract] or skill NEAR/4 enhanc* [Title/Abstract] or performance NEAR/4 acqui* [Title/Abstract] or skill NEAR/4 acqui* [Title/Abstract]
#9	#7 or #8
#10	#3 and #6 and #9

WEB OF SCIENCE

1:	TS=("resident" OR "residents" OR "residency" OR "residencies" OR "registrar*" OR "specialist train*" OR "specialist learn*" OR "specialist educat*" OR "postgraduate train*" OR "postgraduate learn*" OR "postgraduate educat*" OR "GP trainee*")
2:	TS=("video*" or "filming" or "recording*" or "taping")
3:	TS=("Feedback" or "Learn*" or "Training" or "Self-reflection" or "Self-modeling" or "Self-review" or "Coaching" or "debriefing" or "teaching" or "Education*" or performance NEAR/4 improv* or skill NEAR/4 improv* or performance NEAR/4 enhanc* or skill NEAR/4 enhanc* or performance NEAR/4 acqui* or skill NEAR/4 acqui*)
4:	#1 AND #2 AND #3

ERIC THROUGH WEBQUEST

((title:"Feedback" OR "Learn*" OR "Training" OR "Self-reflection" OR "Self-modeling" OR "Self-review" OR "Coaching" OR "debriefing" OR "teaching" OR "Education*" OR performance NEAR/4 improv* OR skill NEAR/4 improv* OR performance NEAR/4 enhanc* OR skill NEAR/4 enhanc* OR performance NEAR/4 acqui* OR skill NEAR/4 acqui*) OR (abstract:"Feedback" OR "Learn*" OR "Training" OR "Self-reflection" OR "Self-modeling" OR "Self-review" OR "Coaching" OR "debriefing" OR "teaching" OR "Education*" OR performance NEAR/4 improv* OR skill NEAR/4 improv* OR performance NEAR/4 enhanc* OR skill NEAR/4 enhanc* OR performance NEAR/4 acqui* OR skill NEAR/4 acqui*))

AND ((title:"resident" OR "residents" OR "residency" OR "residencies" OR "registrar*" OR "specialist train*" OR "specialist learn*" OR "specialist educat*" OR "postgraduate train*" OR "postgraduate learn*" OR "postgraduate educat*" OR "GP trainee*") OR (abstract:"resident" OR "residents" OR "residency" OR "residencies" OR "registrar*" OR "specialist train*" OR "specialist learn*" OR "specialist educat*" OR "postgraduate train*" OR "postgraduate learn*" OR "postgraduate educat*" OR "GP trainee*"))

AND ((title:"video*" OR "filming" OR "recording*" OR "taping") OR (abstract:"video*" OR "filming" OR "recording*" OR "taping"))

SUPPLEMENTARY FILE 3: PREDEFINED OUTCOMES AND VARIABLES

General: citation, year

Methods:

- Aim
- Study design
- Total study duration,
- Sequence generation
- Inclusion criteria

Participants:

- Total number
- Setting (training program)
- Post-graduate year (PGY)
- Recruitment of participants
- Country
- Age
- Sex

Intervention:

- Total number of intervention groups
- Specific intervention
    - Moment of recording was chosen on what basis?
    - Kind of feedback?
    - Other information
- How was patient consent obtained
- Amount of recordings (included)
- Amount of recordings/participant
- Frequency of recording
- Frequency of reviewing videos?
- Time period between recording and reviewing
- Who was recorded (patient, resident, others)
- Place of recording
- Method of recording
    - Operator needed or handsfree
    - Camera
- Editing of recording
- Storage method
- Who viewed the recording

Outcomes

- Outcomes collected; reported
- Time points collected; reported

- Type of learning effect measured
- Investigated competencies
- Used scales or formative assessment tool
    - What tool?
    - When a scale was used: who scored it?

Results

- Number of participants allocated to each intervention group
- Sample size
- Missing participants
- Summary data for each intervention group
- Additional information for the summary data
- Temporal cost of recording
- Monetary cost of recording
- Perceptions of participants
- Challenges encountered

Miscellaneous

- Funding source
- Key conclusions of the authors

SUPPLEMENTARY FILE 4: COMPLETE DATA TABLE

Source	Methodology (part 1)
	Aim
Kava et al.[200]	The utility of resuscitation video-assisted self-reflection compared with self-reflection alone
Goldberg et al.[196]	The extent to which a short course of training sessions increases the accuracy of rating psychiatric disturbances in patients
Wouda et al.[102]	The effects of residents' communication self-assessment and supervisor feedback on residents' (1) communication-competency awareness, (2) their patient-education competency, (3) their patients' opinion
Birnbach et al.[202]	To determine whether teaching with video review improves epidural anaesthesia skills of anaesthesiology residents (abstract) To assess the effectiveness of video filming as an adjunct for teaching obstetric regional analgesia techniques to residents (main text)
Isreb et al.[195]	(1) To test the feasibility of using synchronised video-review as a formative assessment tool to support UK surgical training. (2) Video-review was used as a vehicle to gain deeper understanding about the role of feedback and reflection in the current UK surgical training environment.
Hays et al.[199]	The changes in self-evaluation of postgraduate general-practice trainees in consultations with genuine patients
Son et al.[203]	The feasibility and efficacy of using Google Glass to improve (1) otolaryngology residents' patient-physician communication and (2) patient satisfaction scores
Parker et al.[201]	To develop and evaluate a feasible, authentic pharmacist-led prescribing feedback intervention for doctors-in-training, to reduce prescribing errors
Guerrier et al.[204]	To assess the impact of video filming on medial canthus episcleral block performance of anaesthesiology trainees.
Mazer et al.[197]	To compare quantitative participant evaluations of this coaching intervention with qualitative dialogue analysis of the educational experiences by independent observers. By examining multiple sources of data, the study aims to investigate the role of third-party analysis as an adjunct to self-assessments of participants. As a secondary benefit: to demonstrate the value of mixed methodology in evaluating surgical educational interventions
Hu et aL.[198]	Is post hoc video-based coaching an effective modality for teaching residents to operate?

Source	Methodology (part 2)		
	Study design	**Total study duration**	**Sequence generation**
Kava et al.[200]	Prospective, randomised, controlled pilot study	3 months (August, September, October 2018)	Not specified
Goldberg et al.[196]	Prospective, randomised, controlled trial	1 year 3 months (July 1978 until September 1979)	Not specified
Wouda et al.[102]	Prospective, single group pretest and posttest	Not specified	Not applicable (N/A)
Birnbach et al.[202]	Prospective, randomised, blinded study	30 days	Not specified
Isreb et al.[195]	Prospective, design-based study, single group pretest and posttest	Not specified	N/A
Hays et al.[199]	Prospective, single group pretest and posttest	Not specified	N/A
Son et al.[203]	Prospective, observational, single group pretest and posttest	3 months	N/A
Parker et al.[201]	Prospective, mixed-methods: quantitative qualitative	73 days from November 2016 to February 2017	N/A
Guerrier et al.[204]	Prospective, randomised	Not specified	Randomization occurred after a preliminary training session and carried out by an individual outside the research team using a computer-generated program.
Mazer et al.[197]	Prospective, single group pre-test posttest	Not specified	N/A
Hu et aL.[198]	Prospective, single group pretest and posttest	Not specified	N/A

Source	Methodology (part 3)
	Inclusion criteria
Kava et al.[200]	Residents: (1) Second or third-year emergency medicine (EM) residents in good standing; (2) On an EM rotation during August-October 2018; (3) Having a resuscitation on a day that a member of the study staff was present to record Patients: Triaged as a resuscitation by emergency medical services or a triage nurse, which comprises (1) patients who have an immediate life- or limb-threatening disease process, or (2) patients with vital sign abnormality with clear evidence of hypoperfusion
Goldberg et al.[196]	In phase 1 of the study, baseline measures were calculated for each of the 45 residents. Within each year of training, the 8 residents with the least satisfactory coefficients were selected and randomly assigned to an index or control group.
Wouda et al.[102]	Not specified
Birnbach et al.[202]	Clinical Anaesthesia year 2-anesthesiology residents beginning their 1-month rotation on the labour and delivery ward
Isreb et al.[195]	Patients were approached after being identified as potential training cases by the supervising consultants. The consultant or the surgical trainee introduced the researcher to the patient and the patient received an explanation about the research along with an information sheet and consent form.
Hays et al.[199]	Family medicine programme trainees in the North Queensland region scheduled to commence their first general-practice attachment term during 1987 and 1988
Son et al.[203]	Not specified
Parker et al.[201]	Participating patients were eligible if they were on 4 or more medications, clinically stable, not confused, willing to participate. Participating residents were doctors-in-training, 1-4 years postgraduation, rotating through the Surgical Assessment Unit at a National Health Service teaching hospital in Southwest England
Guerrier et al.[204]	Anaesthesiology residents without any experience in eye surgery attending a single-week rotation on the ophthalmology service
Mazer et al.[197]	Postgraduate year 4-5 general surgery residents at Brigham and Women's Hospital
Hu et aL.[198]	Postgraduate year 4-5 general surgery residents at Brigham and Women's Hospital

Source	Participants (part 1)		
	Total number	**Setting (training program)**	**Postgraduate year (PGY)**
Kava et al.[200]	10	Emergency medicine	2-3
Goldberg et al.[196]	24	General practitioners (family practice)	1-3
Wouda et al.[102]	44	Dermatology & plastic surgery	Mean years in residency at first participation was 2,5 years
Birnbach et al.[202]	22	Anaesthesiology	2
Isreb et al.[195]	10	Surgical	Range ST3-ST8 (First year specialty trainee to final year)
Hays et al.[199]	21	General practitioners (family practice)	1
Son et al.[203]	5	Otolaryngology	2-5 (PGY-2 (n = 1), PGY-4 (n = 1), PGY-5 (n = 3))
Parker et al.[201]	16	Surgical	1-4
Guerrier et al.[204]	32	Anaesthesiology	Not specified
Mazer et al.[197]	10	Surgical	4-5
Hu et aL.[198]	10	Surgical	4-5

Source	Participants (part 2)			
	Recruitment of participants	**Country**	**Age**	**Sex**
Kava et al.[200]	Residents: Email sent to the second- and third-year classes (convenience sample)	United States of America (USA)	Not specified	Not specified
Goldberg et al.[196]	Process of recruitment not specified	USA	Not specified	Not specified
Wouda et al.[102]	Process of recruitment not specified	The Netherlands	Not specified	Female (n=27), Male (n=17)
Birnbach et al.[202]	Process of recruitment not specified	USA	Not specified	Not specified
Isreb et al.[195]	Patients were approached after being identified as potential training cases by the supervising consultants.	United Kingdom (UK)	Not specified	Female (n=3), Male (n=7)
Hays et al.[199]	Process of recruitment not specified	Australia	Not specified	Not specified
Son et al.[203]	Process of recruitment not specified	USA	Not specified	Not specified
Parker et al.[201]	Recruitment was led by a middle-grade pharmacist, who was already known to the participants since he was the pharmacist allocated to that ward, from November 2016 to February 2017.	UK	23-31 years	Female (n=7), Male (n=9)
Guerrier et al.[204]	Process of recruitment not specified	France	Not specified	Not specified
Mazer et al.[197]	Process of recruitment not specified	USA	Not specified	Not specified
Hu et aL.[198]	Process of recruitment not specified	USA	Not specified	Not specified

Source	Interventions (part 1)	
	Total number of intervention groups	**Specific intervention: moment of recording was chosen on what basis?**
Kava et al.[200]	2 Intervention group: 2PGY2 + 3PGY3 Control group: 3 PGY2 + 2PGY3	Procedure-led
Goldberg et al.[196]	2 Intervention (index) group: 12 (1st year (n=4), 2nd year (n=4), 3rd year (n=4)) Control group: 12 (1st year (n=4), 2nd year (n=4), 3rd year (n=4))	Procedure-led
Wouda et al.[102]	1	Agenda-led
Birnbach et al.[202]	2 Intervention group (video review): n = 11 Control group (nonvideo review): n = 11	Procedure-led
Isreb et al.[195]	1	Procedure-led
Hays et al.[199]	1	Agenda-led
Son et al.[203]	1	Agenda-led
Parker et al.[201]	1	Procedure-led
Guerrier et al.[204]	2 Intervention group: video review Control group: without video review	Procedure-led
Mazer et al.[197]	1	Unclear
Hu et aL.[198]	1	Unclear

Source	Interventions (part 2)	
	Specific intervention: kind of feedback?	**How was patient consent obtained**
Kava et al.[200]	Internal (Self-reflection)	The study was classified as program evaluation/quality improvement, patient consent was not required.
Goldberg et al.[196]	Internal (self-reflection) and external (microteaching)	Not specified
Wouda et al.[102]	Internal (self-assessment) and external (feedback)	A coordinator arranges for consent from patients
Birnbach et al.[202]	Internal (Self-assessment) and external (feedback)	Written informed consent from labouring women and residents to be filmed in the study
Isreb et al.[195]	Internal (Self-reflection) and external (feedback)	Researcher provided information sheet and consent form to patients who were identified as potential training cases
Hays et al.[199]	Internal (Self-assessment) and external (feedback)	Not specified
Son et al.[203]	External (Feedback)	Not specified
Parker et al.[201]	Internal (self-assessment) and external (feedback)	Written informed consent
Guerrier et al.[204]	Internal (Self-assessment) and external (feedback)	Written informed consent
Mazer et al.[197]	Internal (Self-reflection) and external (coaching session)	Written informed consent
Hu et aL.[198]	Internal (Self-reflection) and external (coaching session)	Written informed consent

Source	Interventions (part 3.1)
	Specific intervention: other information
Kava et al.[200]	Audio and video were recorded of EM residents functioning as team leader during a resuscitation in real-time patients presenting to the emergency department. All participants participated in guided self-reflection regarding their capabilities as team leader. Guidance was provided by a "Resident Reflection Sheet". The intervention group watched a recording of their resuscitation while they completed the aforementioned sheet, the control group completed the sheet without access to their recording.
Goldberg et al.[196]	Four sessions: Session 1 - The instructor set forth a simple model for making psychiatric assessments in a family practice setting and showed the trainee videotaped excerpts of his or her own interview style which had been recorded during phase 1 of the project. The trainee reacted to the recording of himself within the framework of the model; the instructor was there to provide microteaching for any specific behaviours that the doctor needed to acquire by giving him opportunities to practise them in the supervision session. Session 2 to 4 - The trainees were shown excerpts from videotaped interviews with patients that had taken place between teaching sessions. The instructor selected excerpts which either showed the trainee practising a behaviour which was new for him or illustrated a moment in an interview which might have been handled better
Wouda et al.[102]	The procedure for Communication Assessment and Feedback using videoed consultations, called video-CAF, consists of the video and audio recording of all consultations at a resident's outpatient clinic, conditional on patient consent. Physical examinations and medical procedures are audio recorded but not video recorded. [...] After completing the clinic, the resident selects two consultations for self-assessment and supervisor feedback. The selection is guided by the consultation's complexity or communication obstacles, as well as by the resident's communication learning objectives. Both resident and supervisor assess the communication quality in the selected consultations with the Control, Explaining, Listening, Influencing (CELI) instrument. Subsequently, they discuss the two selected consultations guided by the resident's learning objectives and the CELI assessments. The medical content of both consultations is also discussed. The feedback discussion, which usually lasts 60–90 min, follows a preset agenda to guarantee the prerequisites of effective feedback. After the feedback discussion, the resident writes down a new list of learning objectives and documents the form in her or his portfolio. The new learning objectives are used as guidelines in the following video-CAF session, which is held between six and twelve months later.
Birnbach et al.[202]	Residents assigned to the VR group reviewed their tapes twice a week with an attending obstetric anaesthesiologist and were asked to identify the technical errors that they had made (self-assessment); then the attending would further review the video with the resident. Although residents assigned to the no video review (NVR) group did not view their video tapes, they were given technique teaching sessions with the same anaesthesiologist. All residents, regardless of group, attended a daily didactic session on obstetric anaesthesia.

Source	Interventions (part 3.2)
	Specific intervention: other information
Isreb et al.[195]	Synchronised images of laparoscopic field inside the abdomen and the overall surgical environment within the theatre were reviewed by the supervising consultant and operating trainee. Video-review session and the following interviews were audio-recorded.
Hays et al.[199]	Each participant was instructed to collect three genuine consultations on portable video camera equipment. A series of self-evaluations was completed for each consultation.
Son et al.[203]	Five residents were recorded. The patients wore the Google Glass device (Glass Explorer Edition Model) with instructions on how to start the recording when the residents entered the room. After the conclusion of the visit with the resident, the recording was finished, and Google Glass removed. The patients were then given a survey to complete. Each patient encounter was recorded as a separate file and scored by 2 faculty, one being an otolaryngologist at another institution and the other being a faculty in medical humanities. The mid-study intervention included a summary of the data from all surveys including the mean and median of each question and his or her video recordings. They were instructed to review the data and videos before the post-intervention patient encounters.
Parker et al.[201]	Prior to the feedback session, the pharmacist watched the video footage; checked the patient's medication history; and reviewed the clinical information and drug chart. The consultation/prescribing footage was reviewed together and discussed. The feedback process was supported by a purpose-made feedback conversation schedule. At the end of each session, the doctor and pharmacist developed and agreed an improvement plan.

Source	Interventions (part 3.3)
	Specific intervention: other information
Guerrier et al.[204]	All residents were given a preliminary teaching session on anaesthesia techniques in ophthalmology. This preliminary teaching session was given by 2 experienced anaesthesiologists and consisted of a single-hour lecture coupled to a video summary of the procedure. Following the observation of 2 medial canthus episcleral anaesthesia procedures performed by 1 supervisor, all trainees were filmed as they performed medial canthus episcleral anaesthesia on the first day and the last day of the week. All residents were supervised and instructed by an anaesthesiologist who was unaware of the resident's group assignment and who was free to instruct as necessary. At day 3, residents assigned to the review group performed a self-assessment while visualizing all their films identifying potential technical errors, which were simultaneously confirmed by an experienced anaesthesiologist. Residents assigned to the no-review group did not view their films, but they were given technique teaching sessions with the same anaesthesiologist in replace. All residents, regardless of group, attended a daily didactic session on ophthalmic anaesthesia, including debriefing and discussion of performance with an instructor and knowledge of the checklist activities expected of them.
Mazer et al.[197]	Videorecorded and audio recorded 1 operation for each resident-coach dyad. Each video formed the basis of a 1-hour one-on-one coaching session conducted by the operative attending.
Hu et aL.[198]	Videorecorded and audio recorded 1 operation for each resident-coach dyad. Each video formed the basis of a 1-hour one-on-one coaching session conducted by the operative attending.

Source	Interventions (part 4)			
	Number of recordings (included)		Number of recordings/participant	Frequency of recording
Kava et al.[200]	20	(specified)	2	Median time between first and second resuscitation recordings was 16,5 days (mean 19,3 days)
Goldberg et al.[196]	Unclear		Not specified	Not specified
Wouda et al.[102]	174	(specified)	2 per participant per video-CAF session	Maximum 3 participations in video-CAF process
Birnbach et al.[202]	Unclear		Not specified	Not specified
Isreb et al.[195]	10	(specified)	1	Once
Hays et al.[199]	108	(calculated)	3	Twice: 3 subsequent recordings at beginning, and 3 subsequent recordings at end of their term (10-13 weeks)
Son et al.[203]	95	(calculated)	20: Ten before and ten after the planned intervention	Not specified
Parker et al.[201]	16	(calculated)	1	Once
Guerrier et al.[204]	288	(calculated)	Mean of 4,5 blocks per resident	Twice: first and last day of the week
Mazer et al.[197]	10	(specified)	1	Once
Hu et aL.[198]	10	(specified)	1	Once

Source	Interventions (part 5)		
	Frequency of reviewing videos	**Time period between recording and reviewing**	**Who was recorded (patient, resident, others)**
Kava et al.[200]	Once, one video	Median between first resuscitation and resident reflection: three days (mean 9,2 days)	Not specified
Goldberg et al.[196]	Not specified	Not specified	Not specified
Wouda et al.[102]	One to three video-CAF sessions, two videos per sessions	Not specified	Not specified
Birnbach et al.[202]	Twice a week during four weeks, amount of videos discussed not specified	Not specified	Not specified (but faces of residents were not recorded on film)
Isreb et al.[195]	Once, one video	Not specified	Patient, trainee, staff
Hays et al.[199]	Twice, each time two different sessions, 3 videos per session	T1-T2: Either on the same day or on the next day T1-T3: within 3 days	Patient, trainee. Not the examination couch
Son et al.[203]	Once, ten videos	Not specified	Resident from patient perspective
Parker et al.[201]	Once, one video	Maximum 3 days	The image was trained on the doctor-in-training
Guerrier et al.[204]	Once, all their recordings (median 4,5 per resident)	2 days (filmed on day 1 and reviewing on day 3)	Resident, patient
Mazer et al.[197]	Once, one video	0-43 days (mean of 13,6 and median of 5,5 days)	Surgical field and entire operating room
Hu et aL.[198]	Once, one video	0-43 days (mean of 13,6 and median of 5,5 days)	Surgical field and entire operating room

Source	Interventions (part 6)		
	Place of recording	**Method of recording: operator needed or handsfree**	**Method of recording: camera**
Kava et al.[200]	Emergency department	Operator needed (study staff present during residents' shift)	Not specified
Goldberg et al.[196]	Consultation rooms	Not specified	Not specified
Wouda et al.[102]	Consultation rooms	Operator needed (coordinator)	Not specified
Birnbach et al.[202]	Labor and delivery ward	Operator needed (obstetric anaesthesiology fellow)	A high-8 video camera with 24xzoom capability
Isreb et al.[195]	Operating room	Not specified	The external field (trainee/trainer view): dedicated high definition digital camera. The intra-abdominal view: video-recording machine in the laparoscopic stack
Hays et al.[199]	Consultation room	Not specified	Portable video camera equipment
Son et al.[203]	Consultation rooms	Operator needed (patient)	Google Glass device (Glass Explorer Edition Model)
Parker et al.[201]	Surgical assessment unit	Not specified	Not specified
Guerrier et al.[204]	Operating room	Operator needed (nurse anaesthesist, not involved in data collection)	Samsung tablet
Mazer et al.[197]	Operating room	Handsfree	In light camera (not further specified)
Hu et aL.[198]	Operating room	Handsfree	In light camera (not further specified)

Source	Interventions (part 7)		
	Editing of recording	**Storage method**	**Who viewed the recording**
Kava et al.[200]	Not specified	Encrypted web-based storage system (Wayne State One Drive)	Resident alone Two faculty experts scored all videos using the Concise Assessment of Leader Management (CALM) instrument
Goldberg et al.[196]	Not specified	Not specified	Resident and instructor
Wouda et al.[102]	Not specified	Storage space not specified. Recordings are destroyed after feedback discussion, unless there was consent to use recordings for research purposes	Resident and supervisor
Birnbach et al.[202]	Not specified	Not specified	Residents and attending anaesthesiologist
Isreb et al.[195]	The 2 video files were synchronised and merged into one file using Adobe Premiere Pro CS6 software.	External field: Not specified Internal field: Extracted via USB memory stick.	Resident and supervising consultant
Hays et al.[199]	Not specified	Not specified	T2: Resident only T3: Resident and medical educator from the Family Medicine Programme
Son et al.[203]	Not specified	Not specified	Respective resident subjects and investigators
Parker et al.[201]	Not specified	Not specified	Respective resident subjects and pharmacist (previewed and together during feed-back)
Guerrier et al.[204]	Not specified	Not specified	Residents, experienced anaesthesiologists
Mazer et al.[197]	Not specified	Not specified	Resident, attending surgeon
Hu et aL.[198]	Not specified	Not specified	

Source	Outcomes (part 1)
	Outcomes collected; reported
Kava et al.[200]	CALM score
Goldberg et al.[196]	(1) Rating by residents: six-point scale of psychiatric disturbance; (2) Rating by an independent research psychiatrist: General Health Questionnaire (GHQ)-28. (3) The main measures of agreement calculated for each doctor were Cohen's kappa coefficient and Maxwell's random-error coefficient
Wouda et al.[102]	(1) Learning objectives; (2) CELI assessments; (3) Patient opinion
Birnbach et al.[202]	(1) Overall grades given by judges (0-40); (2) Grading on thirteen criteria (0-8 per skill, total 104)
Isreb et al.[195]	PBA global summary level of competency
Hays et al.[199]	Rating scale scores
Son et al.[203]	(1) Patient survey; (1) Faculty survey
Parker et al.[201]	(1A) Number of pharmacist interventions (equating a prescribing error as defined by EQUIP study); (1B) Average pharmacist interventions per day; (1C) Average pharmacist interventions per patient; (2) Participant's experiences of the feedback intervention
Guerrier et al.[204]	Akinesia after medial canthus episcleral block performance by the anaesthesiology trainee
Mazer et al.[197]	(1) Teaching points identified in the dialogue analysis; (2) coding for content, initiator, assessments of educational needs, teaching technique; (3) Evaluation questionnaire with structured questions addressing the quality of interactions, content discussed, and differences between the OR and coaching sessions
Hu et aL.[198]	(1) Coding of operating room videorecordings and coaching audiorecordings; (2) Teaching points: initiator, content, teaching technique, tone.; (3) Resident as initiator: open, closed or reflective response from attending

Source	Outcomes (part 2)	
	Time points collected; reported	**Type of learning effect measured**
Kava et al.[200]	T1: First resuscitation; T2: Second resuscitation	Behaviours
Goldberg et al.[196]	T1: Before training; T2: On average two months after the teaching sessions had been completed.	Knowledge, skills
Wouda et al.[102]	T0: Instruction (only for learning objectives); T1: Video-CAF (first session); T2: Video-CAF (second session); T3: Video-CAF (third session)	Behaviours
Birnbach et al.[202]	T1: Day 1 of subspeciality rotation (beginning); T2: Day 15 of subspeciality rotation (middle); T3: Day 30 of subspeciality rotation (end)	Behaviours
Isreb et al.[195]	T1: Post operation; T2: Post video-review	Knowledge, skills
Hays et al.[199]	T1: immediately after the recording of each consultation and therefore prior to observation of the consultation; T2: after observation of each consultations; T3: after a debriefing session with a medical educator; This sequence was repeated twice: S1 = Beginning of the term ; S2 = End of the term	Behaviours
Son et al.[203]	T1: Before intervention; T2: After intervention	Behaviours
Parker et al.[201]	T1: Baseline (50 days); T2: Project (23 days)	Behaviours
Guerrier et al.[204]	T1: Day 1 of rotation (beginning); T2: Day 7 of rotation (end)	Patient/health care outcome
Mazer et al.[197]	T1: Operating room; T2: Coaching session	Knowledge, skills
Hu et aL.[198]	T1: Operating room; T2: coaching session	Knowledge, skills

Source	Outcomes (part 3)	
	Investigated competencies	**Used scales or formative assessment tool: what tool?**
Kava et al.[200]	Leadership abilities	Concise Assessment of Leader Management (CALM- instrument)
Goldberg et al.[196]	Rating psychiatric disturbances in patients	(1) Six-point scale of psychiatric disturbance (2) Scaled version of the (GHQ-28)
Wouda et al.[102]	Communication	Control, Explaining, Listening, Influencing (CELI) instrument
Birnbach et al.[202]	Administering epidural anaesthesia	Criteria by the Inter-Hospital Group for Anaesthesia Education (altered version: 13/35 criteria were used)
Isreb et al.[195]	Laparoscopic cholecystectomy	Procedure Based Assessment forms (PBA)
Hays et al.[199]	Medical expert, communication, management, …	Consultation rating scale (see appendix article)
Son et al.[203]	Communication Technical	(1) 6 questions regarding physician interaction from the Clinician and group survey of Consumer Assessment of Healthcare Providers and Systems survey (2) 14 questions regarding the 6 questions mentioned above, and additional questions regarding self-introduction, hand-washing, proper endoscopy anaesthesia and consent, and empathy
Parker et al.[201]	Prescribing practices	Purpose-made feedback conversation schedule
Guerrier et al.[204]	Technical skills: medial canthus epsicleral block	12-point scale: 4 directions of the gaze scored for akinesia (0-3)
Mazer et al.[197]	Not specified	N/A
Hu et aL.[198]	Not specified	N/A

Source	Outcomes (part 4)	Results (part 1)		
	When a scale was used: who scored it?	Number of participants allocated to each intervention group	Sample size	Missing participants
Kava et al.[200]	Two faculty experts	5	10	0
Goldberg et al.[196]	(1) Residents (2) Independent research psychiatrist	12	24	0
Wouda et al.[102]	Resident, supervisor	44	44	Second session (n=13) Third session (n=13+19)
Birnbach et al.[202]	Judges (four experienced obstetric anaesthesiologists)	11	22	0
Isreb et al.[195]	Supervisor	10	10	0
Hays et al.[199]	Residents, medical educator	21	21	3
Son et al.[203]	(1) Patients (2) Faculty	5	5	1 resident was only able to complete 5 post-intervention patient interviews
Parker et al.[201]	N/A	16	16	0
Guerrier et al.[204]	The surgeon just before incision	16	32	0
Mazer et al.[197]	N/A	10	10	0
Hu et aL.[198]	N/A	10	10	0

Source	Results (part 2.1)
	Summary data for each intervention group
Kava et al.[200]	Median composite gain score (posttest score minus pretest score): - control group = -1.5 (interquartile range, IQR); - intervention group = 0.5 (IQR) The 95% CI for the difference in the medians between the groups was –8.5 to 4.0.
Goldberg et al.[196]	Cohen's kappa (means +- SD). Index group: pre-training = 0.131 (+-0.18), post-training = 0.257 (+-0.20) Control group: pre-training = 0.189 (+-0.16), post-training = 0.077 (+-0.22) Two-way analysis of variance: Pre versus post x Index versus Control: Sum of squares 0.194, p0.035
Wouda et al.[102]	(1) Learning objectives (mean): after instruction = 6,66; after first feedback session = 9,3; after second feedback session = 8,83; - after third feedback session = 8,33 (2) CELI-scores: Control subcompetency scores improved over the video-CAF sessions with 0,48 score points per session (Z-score = 3,118, p = 0,001); Other subcompetencies were not influenced by video-CAF participation (3) Patient scores: Patient opinion correlated with the Explaining subcompetency (r = 0.26, N = 87, p = 0.017) and the Listening subcompetency(r = 0.26, N = 87, p = 0.016). The other subcompetencies, video-CAF participation, and resident characteristics were not related to patient opinion.
Birnbach et al.[202]	Median overall grades (range) Day 1: VR = 21 (4-35), NVR = 12 (8-34) (not significant); Day 15: VR = 32 (14-38), NVR = 24 (16-38) (p0,018); Day 30: VR = 36 (26-40), NVR = 24 (19-38) (p0,001). Median total scores by grading on selected criteria (range) Day 1: VR 54 (0-99), NVR 46 (1-103), NS; Day 15: VR 100 (33-104), NVR 81 (34-104), (p0,09); Day 30: VR 104 (75-104), NVR 82 (46-104), (p0,002) There was mainly continuing improvement beyond 15 days
Isreb et al.[195]	Out of 10 PBA forms: 2 had an additional point on the post-video review PBA compared to the post-operation PBA; 5 had an identical score on the post-operation and post-video review PBA; 3 had either the post-operation or the post-video review points missing
Hays et al.[199]	Mean score: S1T1 = 3,54 ; S1T2 = 3,43 ; S1T3 = 3,38 ; S1ME = 3,33; S2T1 = 3,87 ; S2T2 = 3,7 ; S2T3 = 3,55 ; S2ME = 3,62
Son et al.[203]	All patient-survey questions decreased after the intervention, but only one decreased significantly (displaying respect (p=0,0065)) Faculty survey questions: 11 questions: significant increase in score (p<0,05); 3 questions: increase in score but not significant; 1 question: decrease in score but not significant

<table>
<tr><th>Source</th><th colspan="2">Results (part 2.2)</th></tr>
<tr><th></th><th colspan="2">Summary data for each intervention group</th></tr>
<tr><td>Parker et al.[201]</td><td colspan="2">Mean number of prescribing errors: Pretest = 19.0/d; Posttest = 11.7/d; 38% decrease overall (P < .0001); 20% less errors per patient</td></tr>
<tr><td>Guerrier et al.[204]</td><td colspan="2">
<table>
<tr><td>Review group day 1:
- akinesia score = median 6 (IQR 2-11)
- supplemental injection needed in 34/72 patients
- duration of procedure = median 16 minutes (IQR 12-20)

Review group day 5
- akinesia score = median 12 (IQR 10-12)
- supplemental injection needed in 0/68 patients
- duration of procedure = median 9 minutes (IQR 11-20)

Review group day 5 - day 1 difference
- akinesia score = median 6 (IQR 4-7)
- duration of procedure = median 7 minutes (IQR 4-9)</td><td>Non review group day 1:
- akinesia score = median 6 (IQR 2-9)
- supplemental injection needed in 34/72 patients
- duration of procedure = median 15 minutes (IQR 13-21)

Non review group day 5
- akinesia score = median 8 (IQR 6-10)
- supplemental injection needed in 18/76 patients
- duration of procedure = median 10 minutes (IQR 12-19)

Non review group day 5 - day 1 difference
- akinesia score = median 2 IQR (0-3)
- duration of procedure = median 5 minutes (IQR 3-10)</td></tr>
</table>
Significant differences between review and no review group:
Day 5 akinesia score: p<0,001
Day 5 day 1 difference akinesia score: p<0,001
Supplemental injection day 5: p<0,001
</td></tr>
</table>

<table>
<tr><th>Source</th><th>Results (part 2.3)</th></tr>
<tr><td></td><td>Summary data for each intervention group</td></tr>
<tr><td>Mazer et al.[197]</td><td>Mean values of ratings reported by participant on a 100-point scale
<table>
<tr><td>Resident survey:
- preoperative decision making: OR 60.1, coaching 57.1, not significant
- anatomy: OR 74.0, coaching 63.7, not significant
- steps of procedure: OR 74.2, coaching 81.9, not significant
- technique: OR 72.4, coaching 70.5, not significant
- intraoperative decision making: OR 78.0, coaching 79.2, not significant
- postoperative care: OR 60.2, coaching 41.8, not significant</td><td>Attending survey:
- preoperative decision making: OR 55.2, coaching 47.8, not significant
- anatomy: OR 63.6, coaching 60.9, not significant
- steps of procedure: OR 62.6, coaching 73.0, not significant
- technique: OR 59.7, coaching 67.1, not significant
- intraoperative decision making: OR 64.3, coaching 67.3, not significant
- postoperative care: OR 44.5, coaching 29.6, not significant</td></tr>
</table>
Mean counts of teaching points per hour on basis of transcript analysis
- preoperative decision making: OR 1.28, coaching 1.30, not significant
- anatomy: OR 8.48, coaching 3.10, p=0.01
- steps of procedure: OR 20.30, coaching 7.5, p<0.01
- technique: OR 12.98, coaching 14.30, not significant
- intraoperative decision making: OR 2.77, coaching 9.70, p=0.03
- postoperative care: OR 1.77, coaching 0.90, not significant</td></tr>
<tr><td>Hu et aL.[198]</td><td>Teaching points per unit time: operating room (OR) 63.0 per hour, coaching session (CS) 102.7 per hour
Attendings asking about residents' learning needs: OR 0.28 vs CS 3.30, P = .04
Initiative by resident to direct their education: OR 17% [331 of 1977 teaching points], CS 27% [198 of 729 teaching points], P < .001
Validation of residents' experiences: OR 1.81 vs CS 8.40, P < .01
Asking questions to promote critical thinking: OR 3.32 vs CS 9.30, P = .07
Setting learning goals: OR 0.28 vs CS 2.90, P = .11
Discussion of intraoperative decision making: mean, OR 2.77 vs CS 9.70 instances per hour, P = .03
Discussion of failure to progress: mean, OR 0.13 vs CS 1.20 instances per hour, P = .04</td></tr>
</table>

Source	Results (part 3)
	Additional information for the summary data
Kava et al.[200]	Gain scores for the individual faculty experts were also compared and no significant difference was found for either the control or intervention group (data not shown).
Goldberg et al.[196]	The control group tended to deteriorate in the four months between testing, but this effect was not significant (one-way analysis of variance F = 2 0, p = 0 17). The failure of the interaction between pre-training versus post-training and year of training to reach significance means that in this respect residents beginning their training were no more or less teachable than final-year residents. The improvement in the index group was due not to a modest improvement spread evenly among the 12 doctors but to dramatic improvements in the rating behaviour of 5 of the 12 doctors.
Wouda et al.[102]	/
Birnbach et al.[202]	/
Isreb et al.[195]	/
Hays et al.[199]	/
Son et al.[203]	/
Parker et al.[201]	The statistical process chart demonstrated that this was a statistically significant change with a false negative rate of <6.5%. Interpretation of this decrease makes the assumption that the number of patients (and therefore average number of prescriptions written) was stable throughout the evaluation period but the weekly patient admissions data for the Surgical Admissions Unit over the same period show a backdrop of increasing patient numbers, rising from 51.0 during the baseline period, to 62.8 during the test period and 69.1 during the sustain period. This means that the estimated 38% error reduction may be understating the true benefits of the intervention.
Guerrier et al.[204]	/
Mazer et al.[197]	Although the reported experiences of teaching and coaching sessions by residents and faculty were similar (Pearson correlation coefficient=0.88), these differed significantly from independent observations. Observers found that residents initiated a greater proportion of teaching points and had more educational needs assessments during coaching, compared to the OR. However, neither residents nor attendings reported a change between the 2 environments with regard to needs assessments nor comfort with asking questions or making suggestions. The only metric on which residents, attendings, and observers agreed was the provision of feedback.
Hu et aL.[198]	/

Source	Results (part 4)	
	Temporal cost of recordings	**Monetary cost of recordings**
Kava et al.[200]	Not specified	Not specified
Goldberg et al.[196]	One session lasted approximately 45 minutes	Not specified
Wouda et al.[102]	Feedback discussion usually lasts 60-90 min	Not specified
Birnbach et al.[202]	Not specified	Not specified
Isreb et al.[195]	Review duration ranged from 16 tot 90 minutes, with a mean of 44 minutes	Not specified
Hays et al.[199]	T3: debriefing sessions were of approximately 90 min duration	Not specified
Son et al.[203]	Not specified	$1,500 for the Google Glass model
Parker et al.[201]	The pharmacist watched the video footage (typically 15-20 minutes). Feedback sessions typically lasted 30-45 minutes	Not specified
Guerrier et al.[204]	Not specified	Not specified
Mazer et al.[197]	Not specified	Not specified
Hu et aL.[198]	Not specified	Not specified

Source	Results (part 5)
	Perceptions of participants
Kava et al.[200]	Not specified
Goldberg et al.[196]	Not specified
Wouda et al.[102]	Not specified
Birnbach et al.[202]	All residents stated that they felt somewhat uncomfortable with being taped on day 1, but none was uncomfortable by day 30. Residents who reviewed their videotapes suggested that videotaping motivated them to improve their technique.
Isreb et al.[195]	Candidates favoured the video-review feedback over the standard verbal feedback using PBA, as a formative assessment tool to enhance reflection and feedback. They supported the use of such a tool for key procedures once or twice per rotation to strike the right balance between the time consuming review session and its educational benefits. They expressed concern over the PBA ability to provide the necessary feedback due to difficulty in timely form-filling post procedure, mental overload intraoperatively, and memory fading effect in retrospective form-filling practice.
Hays et al.[199]	Not specified
Son et al.[203]	Not specified
Parker et al.[201]	Acceptability: Although they were conscious of it, being videoed did not pose a barrier to participation. Authenticity: It was a very typical activity. Experience of feedback: overwhelmingly positive. Experience of reviewing the video: very beneficial and provided novel insights. Commitment of behaviour change: many reported that they already had, or intended to, change their behaviour
Guerrier et al.[204]	Not specified
Mazer et al.[197]	Not specified
Hu et aL.[198]	Not specified

Source	Results (part 6)	Miscellaneous (part 1)
	Challenges encountered	**Funding source**
Kava et al.[200]	Not specified	No external funding source
Goldberg et al.[196]	Not specified	Supported by NIMH grant M20 8LR
Wouda et al.[102]	Not specified	The University Medical Center Groningen and the Ahmas Foundation provided financial support for this study
Birnbach et al.[202]	Not specified	Supported in part by a grant from the Society for Education in Anaesthesia, Richmond, Virginia
Isreb et al.[195]	Not specified	Not specified
Hays et al.[199]	Not specified	Not specified
Son et al.[203]	Not specified	No funding
Parker et al.[201]	Not specified	Financial support for this project was provided as a Medical and Educational Goods and Service by Pfizer Ltd; and the South West Academic Health Science Network.
Guerrier et al.[204]	Not specified	No funding
Mazer et al.[197]	Not specified	Not specified
Hu et aL.[198]	Not specified	This work was supported by grants L30 RR031458-01 (Dr Hu) and 2T32 DK00754-12 from the National Institutes of Health, by the Rx Foundation (Hadley, Massachusetts) (Dr Greenberg), and by the Controlled Risk Insurance Company [CRICO]/Risk Management Foundation (Boston, Massachusetts) (Dr Greenberg).

Source	Miscellaneous (part 2)
	Key conclusions of the study authors
Kava et al.[200]	The study showed a positive trend in gain score evaluation of leadership skills for residents utilizing video-assistant self-reflection after resuscitation compared with the non-video-assistant control group
Goldberg et al.[196]	After the training sessions the index group had significantly improved the accuracy of their assessments.
Wouda et al.[102]	This study demonstrated that self-assessment of and supervisors' feedback on residents' communication using videoed outpatient consultations (video-CAF) is feasible and might be effective in improving residents' patient-education competency in clinical practice
Birnbach et al.[202]	Videotaping and video review of residents initiating epidural analgesia on the labour and delivery ward resulted in greater improvement in overall and selected performance criteria than that of a group that did not have video review.
Isreb et al.[195]	This study established the feasibility of using synchronised video-review as a reflection-on-action tool to potentially enhance surgical training by improving feedback. It identified trainees' difficulty in processing intraoperative feedback due to mental overload from the operation. It showed the limitations of current verbal feedback practice, using Procedure-Based Assessment forms, with regard to enhancing technical and nontechnical skills due to denial and memory fading.
Hays et al.[199]	Self-evaluation-based video debriefing may fulfil two important educational goals: - teaching of consultation skills may take place, depending on the structure of the evaluation and the feedback provided - there is potential to develop self-evaluation skills in learners if self-evaluation is incorporated into the routine
Son et al.[203]	This study demonstrates improvements in clinical performance in the outpatient otolaryngology clinic setting can be achieved with the use of Google Glass as a first person recording device and can be easily translated into any ambulatory setting where graduate medical education training takes place.
Parker et al.[201]	Video-stimulated reflection on prescribing events for doctors-in training, supported by tailored pharmacy feedback, significantly reduced prescribing errors and was well received by participants
Guerrier et al.[204]	Video review of residents learning medial canthus episcleral anaesthesia resulted in greater improvement in efficacy than that of a group who did not have a video review.
Mazer et al.[197]	Our findings highlight the importance of considering multiple perspectives during the evaluation of clinical education interventions and therefore have important potential ramifications for residency programs seeking to create and evaluate educational interventions.
Hu et aL.[198]	Video-based coaching is a novel and feasible modality for supplementing intraoperative learning. It is particularly useful for individualizing instruction and feedback to each resident, increasing the depth of what is taught, and teaching higher-level concepts, such as decision making.

Chapter 6: Paediatric Residents 'in the Picture': Stimulating Video-Assisted Self-Reflection During Workplace Learning – A Pilot Study

"The whole purpose of education is to turn mirrors into windows"

Sydney. J. Harris

Under peer review

1. Abstract

Introduction

Reflective practices are crucial in postgraduate medical education, but memory-based reflection on action may lead to inaccuracies. Video review might enhance reflective practice. The research question is three-fold: (1) What is the effect of video review on self-reflection? (2) How do residents experience video review? (3) What are the facilitators and obstacles to integrating video review in clinical practice?

Methods

A prospective, nonrandomised single-group pretest-posttest pilot study was conducted. Residents engaged in self-reflection on a personal recorded clinical activity, before and after video review. These reflections were analysed quantitatively and qualitatively. Participating residents were interviewed to explore their experiences with video-assisted self-reflection during clinical training. Additionally, both facilitators and obstacles encountered in the process of recording or reviewing a video were documented.

Results

Fifteen video recordings from 10 residents were included. Significant differences were observed before and after video review regarding the number of areas for improvement, take-home messages, and total self-reflection fragments. Participants recognised more strengths in the roles of medical expert and collaborator, as well as more areas for improvement in the roles of medical expert, communicator, and collaborator. Participating residents reported positive experiences and deemed the integration of video review in residency training feasible. Several obstacles, such as time constraints and adherence to privacy regulations, were encountered.

Discussion

Video review was positively received and appears to stimulate deeper self-reflection among residents. Several facilitators and obstacles for future integration were identified. The recommendations focus on acclimating residents to video-assisted self-reflection, optimising the design of the self-reflection form, streamlining the recording process, and establishing a legal framework to support the use of video in residency training.

2. INTRODUCTION

Reflective practice is an important aspect for WPL within medical education. It underpins self-regulated learning, intending to enhance and deepen learning.[91,208] Self-reflection, as delineated in Donald Schön's theory of reflective practice, encompasses two categories: *reflection in action*, involving prompt evaluation and adaptation of one's behaviour while actively engaged in a task, and *reflection on action*, entailing the process of reflecting on past situations.[84,209,210] Relying on memory for reflection on action can lead to inaccuracies due to emotional involvement or cognitive overload, leading to potentially limited learning.[98-100,211]

External information enhances self-reflection, for which supervisors traditionally observe residents' clinical performances. This direct observation facilitates the refinement of clinical skills, can provide formative and summative assessment, and facilitates tracking residents' progress.[51,212] However, direct observation is not always feasible due to logistical issues, such as the number of residents exceeding the number of supervisors and conflicting schedules, which causes direct observation to happen infrequently.[212,213] Therefore, alternatives are needed to guide reflective learning. With video recording of clinical performances, the supervisor but also the resident can review the performance. Video-review might be a good alternative to external guidance for reflection, because of the following benefits.

Video recording can enhance learners' memory because video review, which involves analysis of residents' clinical practices through recorded footage, can minimise the discrepancy between how residents perceive their performance and their actual performance.[98] When reviewing a video, the learning events can be recalled in a realistic context, enabling the identification of previously missed aspects.[98-103] Recording videos eliminates the need for an extra observer in the room, alleviating residents' fear of assessment or mistrust and reducing potential patient behaviour alterations.[137,214-217] Despite concerns about cameras altering behaviour, previous studies have shown that individuals might adapt more quickly to a camera integrated into the room than to an additional person.[137,215,216] All these benefits not only enhance the quality of self-reflection, but it can also foster improved feedback and assessment.[99,101-103,218]

The positive effects of video review on learning, assessment and supervision in practice supported the frequent use of video review in resident training.[218] However, guidelines for

effective video review are limited, necessitating further research to optimise protocols and effectively prepare for larger studies. Pilot studies are essential due to challenges in implementing video technology, technology acceptance, and the complexities of conducting randomised controlled trials.[219] Recent pilot studies integrating video review to foster self-reflection in emergency and surgical departments have been published, both indicating that implementation of the video review would benefit resident training after optimising the protocol.[200,220] The present pilot study aimed to evaluate the integration of video review in the training of paediatric residents at a neonatal intensive care unit (NICU). The research question (RQ) is three-fold: (1) What is the effect of video review on self-reflection? (2) How do residents experience video review? (3) What are facilitators and obstacles of integrating video review in clinical practice? Based on the results, this article aims to formulate recommendations for enhancing future video-reflective practices.

3. Methods

We conducted a prospective, nonrandomised single-group pretest-posttest pilot study with a mixed methods design. Residents performed two guided self-reflections on a personal recorded clinical activity, one before (pre) and one after (post) the video review, to investigate the effect (RQ1). Additionally, these residents completed a survey and were interviewed, investigating how they experienced the use of video in clinical training (RQ2). Lastly, the study investigator documented facilitators and obstacles during the study process (RQ3). For a complete overview of the flow of the study, see Supplementary File 1. The study protocol was approved by the Ethics Committee of University Hospital Antwerp, Belgium (Project ID 2021-1725-EDGE 2346).

Setting and population

This study was conducted from April to September 2022 and from June to December 2023 at the neonatal intensive care unit (NICU) of a tertiary-care university hospital in Belgium, with about 400 admissions per year. Participants included paediatric residents (post graduate year 3 to 5) working at the NICU. All residents who worked at the NICU during the day were informed about the study at the start of their rotation. They were repeatedly reminded of the study and the opportunity to record learning moments throughout the day. Additionally, they were actively asked if an automatically recorded neonatal life support (NLS) event, in which they were involved, could be included in the study. Residents who were on call at the NICU

were only approached after participating in an automatically recorded NLS event. Informed consent of both parents and the resident was needed in order to include a video in the study. Other healthcare providers, involved in the neonate's care, needed to verbally agree to record a video at the NICU as their voice could be recorded; however, they were never captured on screen.

Videos (audio included) were recorded in two situations. The first situation involved NLS performed in a fully equipped, dedicated room, adjacent to the delivery room. This learning moment was unpredictable, as NLS can occur suddenly and unexpectedly. All actions in the NLS room were hands-free recorded through a discretely integrated camera system (Dome IR Camera, Dome Camera, Indoor Fisheye Covert Pinhole Camera). The cameras streamed their recording directly through a cable to a secured, local computer without internet access. In order to guarantee privacy and data protection according to the European General Data Protection Regulation (GDPR), videos could only be reviewed through a video management system (Digifort Professional Surveillance Client) on this local computer. All new admissions were checked multiple times a week, and the primary researcher actively asked residents whether an interesting NLS performance they could use as a learning moment had taken place. If this was the case and the resident agreed to review the video, written informed consent from the infants' caregivers was needed before reviewing the footage for this study. Without this consent, the footage was deleted and a review was impossible.

The second situation involved residents identifying potential learning moments at the NICU. With the infants' caregivers written consent, a study investigator set up the camera (Sony FDR-AX53 4K Camcorder with an external microphone RODE VideoMic PRO Rycote) before the learning moment. The videos captured only the resident on screen; there were no images from patients or parents, but audio of parents could be recorded if they were talking to the residents. These videos were transferred to a local, secured server and could only be reviewed by paediatric staff and residents. For both situations, participating residents also provided written informed consent.

Intervention and outcome measures

A complete overview of the intervention, outcome measures and analysis can be found in Supplementary File 1. Residents could record multiple videos during the inclusion period. For

RQ1, residents received a targeted self-reflection form electronically after each video recording. Each resident completed the form twice: 1) pre video-review, prompting self-reflection based on memory, and 2) post video-review, prompting reflection based on the recording. Measuring self-reflection could be interpreted as a Kirkpatrick level 2 effect, assessing the intervention's impact on the resident.[221] The form, specifically designed for this study, consisted of two parts (Supplementary File 2). The first part included two rating scales for participants to evaluate their satisfaction with their performance and the perceived learning significance of their performance. The scale ranged from 1 to 10 (from lowest to highest satisfaction or significance). The second part encompassed answers on four key inquiries: (1) identification of strengths (strong points, SP), (2) recognition of areas for improvement (areas for improvement, '*werkpunten*', WP), (3) observation of any additional insights (extra's, XTR), and (4) identification of key take-home messages (THM).

For RQ2, residents completed a survey aimed at assessing their encounters and perspectives regarding video review and subsequent self-reflection at the study's end. These findings were then further explored through semi-structured interviews. A comprehensive breakdown of the survey and interview schedule can be found in Supplementary File 3. The questions delved into various facets, such as encompassing general experiences, technical nuances, practical considerations, emotional dimensions, and the educational significance of examining their recordings. We employed method triangulation, combining interviews with in-depth questions about the survey to strengthen result interpretation through multiple perspectives.[124]

For RQ3, the study investigator documented both the facilitators and obstacles encountered while recording or reviewing videos during data collection. This information was gathered by observation or informal conversations with the participating residents, and written down in a separate Word® file.

Data analysis

For RQ1, content from the second part of the self-reflection forms was structured with one competency per line, facilitating the comparison pre and post video review across four categories (SP, WP, XTR, THM) as well as in total. Afterwards, qualitative content analysis was employed, initially deriving competencies through an inductive process and subsequently

aligning them with pre-existing competencies and CanMEDS roles validated in our earlier study.[127,222] This methodological approach facilitated the investigation of changes in self-reflection content by comparing matches between self-reflections and competencies pre and post video review. The primary author (MR) undertook initial familiarisation with the data, generated meaningful codes, and matched them to competencies. Another researcher (AM) reviewed 10% of this coding to ensure researcher triangulation.[223] Any opposing opinions were resolved through discussion. All these analyses were performed in Microsoft Excel®.

For RQ2, the interviews were transcribed with the automatic transcription software HappyScribe. The survey open-ended questions and the interview transcripts were analysed by the primary author (MR) to gain in-depth insights using strengths, weaknesses, opportunities and threats (SWOT).[224] Strengths and weaknesses are hereby inherent to the system, while opportunities and threats are external factors.[224] Again, 10% of the interviews were independently double coded by another researcher, who did not conduct any interviews (MVW).[223] The analyses of the interviews were conducted in NVIVO 12.

For RQ1 and RQ2, descriptive statistics were employed to describe the characteristics of the scores on the Likert-like scales in the first part of the self-reflection forms, the quantitative characteristics of the self-reflection fragments in the second part, and the scores on the Likert-like scales in the survey. When statistically significant differences were calculated, the Wilcoxon Signed Rank Test was used. These statistical analyses were performed using IBM SPSS Statistics (Version 29).

For RQ3, facilitators and obstacles were tracked and merged were possible.

4. Results

Research question 1

This pilot study included 15 video recordings from 10 residents. They reviewed one (n=6), two (n=3) or three (n=1) videos. An overview of the descriptive statistics of the videos can be found in Table 1. The first two rows contain the numbers representing residents' satisfaction with their performance and the perceived learning significance of that performance for their learning, both pre and post video review. No significant differences were found when comparing numbers pre and post video review. The five last rows present the number of analysed self-reflection fragments pre and post video review in each category (SP, WP, XTR,

THM) and in total. A significant difference was found between the number of areas for improvement, take-home messages, and the total number of self-reflection fragments.

Table 1. Analysis of the self-reflection fragments*. Pre = before video review. Post = after video review. SP = strong points, identification of strengths. WP = 'werkpunten', recognition of areas for improvement. XTR = extras, observation of any additional insights. THM = take-home messages. * = p-value was calculated by the Wilcoxon Signed Rank Test. Significance was defined as p<0.05.*

Subject	Pre video review		Post video review		Significance
	Total number of fragments	Mean	Total number of fragments	Mean	p-value*
Satisfaction own performance	-	7,13	-	7,33	0,426
Learning value experienced during the clinical activity	-	7,67	-	8,00	0,609
SP	48	3,20	53	3,53	0,59
WP	28	1,87	47	3,13	***0,017***
XTR	3	0,20	5	0,33	0,317
THM	24	1,60	38	2,53	***0,029***
Total	103	6,87	143	9,53	***0,017***

The results also provide insights into how residents' opinion on their performance changed after video review. There were more fragments containing areas for improvement than strong points after video review. Competencies indicated as strengths remained a strength in 66.67% of the fragments, areas for improvement remained areas for improvement in 51.35% of the fragments. Competencies indicated as a working point turned into a strength in 18.92% of the fragments and strengths turned into areas for improvement in 13.89% of the fragments. There were 30 new areas for improvement after video review (15 medical expert, 1 leader, 8 communicator, 6 collaborator), and 20 new strengths (12 medical expert, 2 leader, 2 communicator, 4 collaborator).

All fragments were coded into different (sub)competencies and linked to CanMEDS roles (Table 2). Strengths in the roles of medical expert and collaborator increased, while areas for improvement increased in the roles of medical expert, communicator, and collaborator. Take-home messages increased in all roles except for the professional role.

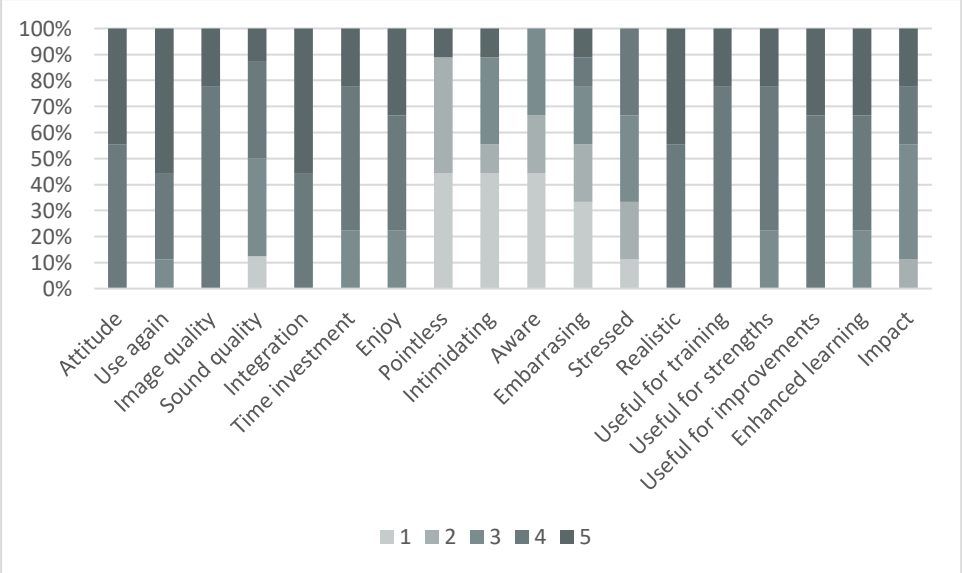
Table 2: fragments coded to competencies and CanMEDs roles. *Pre = before video review. Post = after video review. SP = strong points, identification of strengths. WP = 'werkpunten', recognition of areas for improvement. THM = take-home messages.*

CanMEDS role	Competency	SP		WP		THM	
		Pre	Post	Pre	Post	Pre	Post
Medical expert		**22**	**25**	**14**	**24**	**11**	**13**
	Establish a management plan	4	6	1	0	3	2
	Continuous improvement of care	1	1	1	1	1	0
	Knowledge own competency	1	0	0	0	0	0
	Procedural methodology protocol	7	7	2	5	1	3
	Follow-up on parameters	7	6	5	8	2	5
	Technical skills	2	5	5	10	4	3
Communicator		**12**	**8**	**6**	**13**	**5**	**12**
	Non-verbal communication	0	1	1	3	0	3
	Mode of communication with parents	1	2	0	5	1	5
	Content of parent communication	5	0	1	3	1	1
	Involving patients and their environment in patient care	6	5	2	2	3	3
	Introducing yourself	0	0	1	0	0	0
	Creating the right environment	0	0	1	0	0	0
Collaborator		**5**	**14**	**4**	**6**	**2**	**7**
	Content of communication with other healthcare professionals	1	2	1	1	0	1
	Collaboration	0	2	1	0	0	0
	Communication with colleagues	4	10	2	5	2	6
Leader		**3**	**3**	**3**	**3**	**1**	**2**
	Team task allocation	2	3	0	2	0	1
	Knowing the team	0	0	1	0	1	0
	Leadership	1	0	2	1	0	1
Professional		**6**	**3**	**1**	**1**	**1**	**0**
	Professional behaviour	6	3	1	1	1	0

RESEARCH QUESTION 2

Nine out of 10 participating residents completed both the survey and interview. Figure 1 and table 3 give an overview of the quantitative results of the survey, the results of the interviews provide more insight into the quantitative results.

Figure 1 and Table 3: survey about the perceptions of residents after their participation in video review. *A: 1 = very negative, 5 = very positive. B: 1 = definitely not, 5 = definitely yes, C: 1 = very poor, 5 = very good. D: 1 = not at all feasible, 5 = certainly feasible. E: 1 = not at all, 5 = absolutely yes.*



Question	Answer code	Mean	Median	Range
What is your attitude towards video use in your training?	A	4,44	4,00	4-5
Would you use the technology again if given the chance?	B	4,44	5,00	3-5
How did you find the quality of the image?	C	4,22	4,00	4-5
How did you find the quality of sound?	C	3,39	3,50	1-5
Do you think it is feasible to integrate videos into the training?	D	4,56	5,00	4-5
Did you feel the time it took was worth it for what you got out of it?	E	4,00	4,00	3-5
Did you enjoy working with video?	E	4,11	4,00	3-5
Did you find it pointless to work with video?	E	1,89	2,00	1-5
Did you find the camera intimidating?	E	2,22	2,00	1-5
Were you always aware that you were being filmed?	E	1,89	2,00	1-3
Did you find it embarrassing to videotape yourself?	E	2,44	2,00	1-5
Were you stressed about using the video for yourself?	E	2,89	3,00	1-4
Did you think the video footage gave a realistic picture of your performance?	E	4,44	4,00	4-5
How useful did you find rewatching your own video for your training?	E	4,22	4,00	4-5

How useful did you find video in identifying your own strengths?	E	4,00	4,00	3-5
How useful did you find video in identifying your own areas for improvement?	E	4,33	4,00	4-5
Did you find your learning enhanced by video?	E	4,11	4,00	3-5
Did the videos have an impact on your clinical practice?	E	3,56	3,00	2-5
Question	**Answer**			
Have you experienced technical problems?	Yes (n=2). No (n=7).			
What did you consider to be a feasible number of videos to record during the study period?	≥ 1 month (n=5). < 1 month (n=4).			

The interview results are described below. A complete overview of the codebook can be found in Supplementary File 4.

INTERNAL FACTORS: STRENGTHS

The participants identified several strengths of video-guided self-reflection. Video is an objective medium for self-reflection as it captures the residents' actions truthfully. This is largely attributed to the participants' gradual disregard for the camera's presence, which seamlessly blended into the environment.

> "If you effectively activate them, then you do that well in advance before the baby arrives. Then you're sort of forgotten that those cameras are there, and they're quite subtly concealed." (Resident 4)

Moreover, one resident pointed out that the selection of videos for review, which took place after their recording, significantly contributed to the sense of authenticity of their recorded actions. Another strength was that other stakeholders (supervisors, peers, ...) had the opportunity to observe too, and that the objectivity of video could be ideal for the provision of feedback.

> "With supervisors, […], you can really get something meaningful out of it for your own learning. To get feedback on that again, I think that would really be valuable." (Resident 6)

Video review encouraged learning by promoting self-reflection, uncovering insights in areas needing improvement, affirming strengths, and leaving participants feeling more positive about their actions afterwards. Novel insights stemmed from comparing self-reflection pre and post video review, observing oneself, witnessing others' actions and interactions, and revisiting certain moments as needed.

> "What was good […], was first evaluating yourself, without reviewing [the video], so that you can compare that evaluation without and with the review." (Resident 8)

Video review can serve various purposes, being applicable across diverse situations and competencies. Half the residents indicated that video review somehow had an impact on their behaviour.

INTERNAL FACTORS: WEAKNESSES

Some inherent weaknesses of video review included the fact that, regardless of the speed at which the camera was disregarded, there was typically an initial awareness. Almost all residents expressed discomfort when watching or listening to themselves for various reasons: they simply disliked the process, felt stressed about reviewing, feared having their errors explicitly displayed, or were generally self-critical. Additionally, one resident noted that the impact of this single video-guided self-reflection was rather limited.

> "I just don't like to look at myself, how I'm doing things. But I do try to look at it objectively and try to analyse what was good and what was bad". (Resident 7)

Moreover, everyone encountered some form of technical issue, such as missing certain angles to observe the situation, problems with audio playback, or the necessity for a certain level of technological competence to navigate the video review system. Furthermore, due to safety considerations, the videos had a limited retention period and could not be accessed for review from any location, which was perceived as a drawback of the current setup.

EXTERNAL FACTORS: OPPORTUNITIES

The participants identified several opportunities for video-guided self-reflection. Optimising time investment was crucial, achievable through easily set-up materials or practical assistance, automatic recording, receiving feedback in advance, or the ability to select specific segments for review. Integrating the tool into the current ePortfolio system is beneficial. It would also

be advantageous for residents to engage in two-way feedback by providing input to their supervisors, who were also recorded. Use of the tool would be stimulated by ensuring readily available materials, sufficient reflection content, positive past experiences, self-review capabilities, and reminders to engage in video-review.

> "Why can't you create some kind of thing where it's not just my assessment? Why isn't it *our* assessment? […] Suppose you're going to review that with your supervisor, you first look at it separately, then together or something like that. Yeah, why does the supervisor have to assess me? Can't I assess them as well?" (Resident 10)

Integration into residents' training was viewed as beneficial, as it would familiarise them with the tool through systematic use. Increased frequency of use was deemed to have a greater impact. Dedicated time and linking it to mandatory tasks would prevent it from being seen as an additional burden. Supervisors were encouraged to take a more proactive role in encouraging resident engagement. Additionally, the videos could serve as valuable teaching moments when reviewed collectively in group settings.

EXTERNAL FACTORS: THREATS

The most frequently cited threat was time constraints, stemming from the need for dedicated time, residents' struggles in prioritising video review amidst their workload, additional steps required before self-reflection, and uncertainty about how much time they needed to spend on performing the self-reflection. Half of the residents expressed a need for external motivation, with some admitting to engaging solely for helping the study rather than personal and professional development.

> "If you hadn't done it in a study context either, I don't know how actively... Unless it really had to, I don't know if I would do it so actively myself." (Resident 1)

Other noted threats included discomfort with being filmed, a sense of already having excessive workloads, and the necessity for deliberate effort to engage in self-reflection. Potential future threats could entail learning saturation, limiting the frequency of video use, an increase in events requiring consent for filming, and considerations regarding patient privacy in shared spaces.

RESEARCH QUESTION 3

We encountered various obstacles complicating the video recording or reviewing process, including emotionally charged parents hesitant to provide consent, the absence of parents for pre-consent arrangements, language barriers with parents. Other obstacles were resistance from other healthcare professionals against recording, task delegation to the supervisor, occasional oversight in turning on the microphone, the resident perceiving the previous video as not having occurred sufficiently long ago, video review without subsequent reflective documentation, and the resident opting not to review the recording. Conversely, certain factors facilitated the recording or review of videos. These included minimising the time gap between an NLS event and the consent procedure, personally addressing residents to encourage their participation, and providing biweekly personal reminders.

5. Discussion

Reflection-on-action is crucial in PGME for fostering learning. Video review might help in optimising self-reflection, leading to improved learning. This pilot study evaluated three RQ.

The first RQ aimed to evaluate the effect of video review on self-reflection. The results showed an increase in both strengths and opportunities, possibly meaning that video review enhanced self-reflection. The second RQ aimed to look for resident's experiences with video-assisted self-reflection, which were mainly positive. The third RQ inventoried the obstacles and facilitators in integrating video review for self-reflection in a NICU. All these results led to the formulation of five recommendations that will be elaborated in this discussion. These recommendations need to be tested in follow-up studies that can further inform video-assisted self-reflection practices in PGME.

The first recommendation is to accustom residents to video-assisted self-reflection by integrating it into their training. In this pilot study, residents expressed enthusiasm about using the tool again, and they believed it was feasible for future integration in PGME. However, engaging in video-reflection for the first time seemed to be a significant barrier, as no one knew what to expect. It seems important to elaborate on the benefits of this tool for residency, to create the mindset that it is normal to use in and beyond residency, and to stimulate its use through frequent exposure. This customisation is essential for the success of video review [101,225].

The second recommendation is to support the reflection process through a concise self-reflection form before and after reviewing a video. Although a supervisor's guidance in the reflection process has been described as essential for providing context, this is not always feasible in clinical practice [91,226]. Video review seems suitable for providing additional insights to residents' self-reflection without the need for external feedback [98-100,211]. Additionally, for adult learners at the PGME level, mastering the skill of self-reflection without a supervisor is crucial [227]. A specific self-reflection form was developed that included strengths, areas for improvement, and a neutral box for take-home messages. This can help residents effectively recognise and understand their clinical behaviour, thereby supporting the learning process without direct supervisor involvement.

A new insight from this study is that paediatric residents specifically indicated that the comparison of their self-reflection before and after video review, based on the self-reflection form, was valuable for their learning. By reflecting on their behaviour from memory and then comparing this with the reflection based on video, they gained insights into how accurately they could assess themselves.

Some residents appreciated the simplicity of the form, which helps avoid reflection fatigue [228]. However, analysis showed that most self-reflection fragments aligned with the medical expert role, while the leader and professional roles were barely mentioned. Although a supervisor's presence during the recorded action may limit reflection on the leader role, these roles remain important within the NLS structure. Notably, the communicator and professional roles were the only ones with fewer strengths identified after video review. Wouda et al. found that guided reflection could encourage consideration of roles beyond medical expert, such as communicator [102], suggesting that video review alone may not be sufficient to stimulate deep reflection on all the CanMEDs roles. Further research is needed to explore how to encourage reflection on additional roles without overburdening the self-reflection form.

The third recommendation is to design the reflection form to prompt residents to first reflect on their strengths. Although interview responses suggest a focus on areas for improvement in the videos, the analysis revealed a greater prevalence of strengths (n=101) compared to areas for improvement (n=75). Interestingly, despite the resident's initial intention to identify areas for improvement and a subsequent increase in areas for improvement, their satisfaction with

performance did not decrease after video review. Some residents spontaneously noticed their strengths, while others acknowledged that the self-reflection form prompted them to do so. Incorporating a deliberate reflection on strengths before addressing areas for improvement appears crucial for future integration of video in PGME, as this may positively influence residents' emotional well-being and overall satisfaction with their actions. This approach also addresses residents' concerns about an excessive focus on mistakes, aligning with previous research [106,225,229]. However, further research is needed to confirm this hypothesis.

The fourth recommendation is to streamline the recording process by using multiple integrated, secured cameras with automatic recording. Time investment needs further optimisation, and automatic recording is one approach to achieve this [220]. While this has already been implemented, there is potential for further expansion and the integration of additional measures. Assigning a dedicated individual, such as an administrator or supervising faculty member, could facilitate the management of informed consents, assist residents new to video-assisted self-reflection, help with video management systems, and provide timely reminders for video reviews. Depending on the volume of recorded videos, these tasks may require an estimated 15 to 75 minutes per day, but it would enhance the efficiency and effectiveness of the video reflection process, ensuring it remains a valuable and time-efficient component of residency training.

The fifth recommendation is to provide a suitable legal frame that balances education with privacy and data protection regulations. We encountered challenges with the GDPR and found no robust legal basis for medical education research in this aspect. This highlights the need for closer cooperation between legal and educational departments.

Self-reflection based on video review has proven valuable for the participants in this study. However, some residents expressed during interviews that they were also interested in receiving feedback from supervisors after their self-reflection. Although this aspect was not included in the current study, it would be worthwhile to compare residents' self-reflections with supervisors' feedback in future research. Additionally, comparing feedback between supervisors and peer residents could present another interesting avenue for exploration.

6. LIMITATIONS

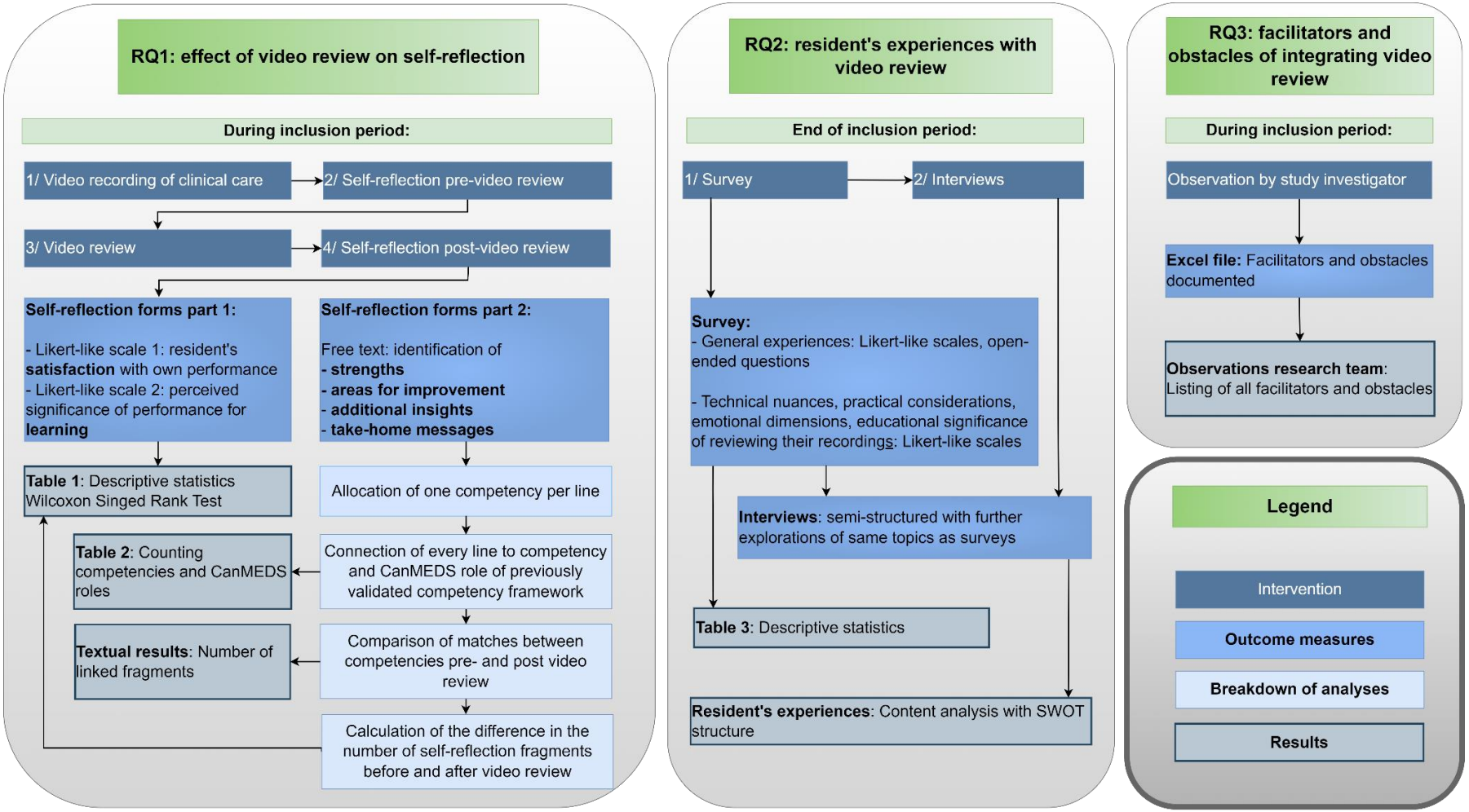
There were several limitations. Firstly, this pilot study was conducted at a single institution within a specific department (NICU), limiting the generalisability of the results. To generalise and test the results of this study, future integration efforts could benefit from involving a larger sample size and multiple departments. Secondly, the limited number of voluntary participants may have biased the results towards a positive effect, as those who participated might be more inclined towards the use of video and more motivated to engage in self-reflection. Thirdly, there was considerable heterogeneity in the included videos, ranging from a calm briefing to an intensive NLS event, which could potentially affect the depth of self-reflection required. Lastly, as this was not a case-control study, we cannot differentiate whether the improvements in the self-reflections are due to the effect of reviewing a video, or are caused by simply repeating the self-reflection.

7. CONCLUSIONS

This pilot study evaluated the integration of video review in the training of paediatric residents at a neonatal intensive care unit (NICU). The results indicate that video review improved self-reflection by confirming strengths, offering enhanced insights into areas for improvement, and stimulating the formulation of key take-home messages. Five recommendations were formulated which need to be tested in follow-up studies: (1) to accustom residents to video-assisted self-reflection by integrating it into their training, (2) to support the reflection process through a concise self-reflection form before and after reviewing a video, (3) to design the reflection form to prompt residents to first reflect on their strengths, (4) to streamline the recording process by using multiple integrated, secured cameras with automatic recording, and (5) to provide a suitable legal frame that balances education with privacy and data protection regulations. These can further inform video-assisted self-reflection practices in postgraduate medical education.

8. SUPPLEMENTARY FILES

SUPPLEMENTARY FILE 1: A COMPLETE OVERVIEW OF THE INTERVENTION, OUTCOME MEASURES AND ANALYSIS OF THE STUDY.



SUPPLEMENTARY FILE 2: SELF-REFLECTION FORM

Which action did you record using video?

Drop down menu with the possibility for free text

Are you satisfied with the recorded action?

Likert-type scale with 1 meaning very dissatisfied, 10 meaning very satisfied

What were your strengths during the past action? What did you do well? What would you do the same next time?

Free text

What were your areas for improvement during the past action? What did you feel didn't go as well? What would you prefer to do differently next time?

Free text

Did anything else catch your attention during this action? If yes, what?

Free text

How educational did you find this action?

Likert-type scale with 1 meaning not educational at all, 10 meaning very educational

What will you take with you to the next similar action?

Free text

SUPPLEMENTARY FILE 3: QUESTIONNAIRE AND INTERVIEW SCHEDULE

QUESTIONNAIRE

GENERAL

How do you feel about the use of video in the training? (Circle your answer)

Very negative 1 2 3 4 5 Very positive

What advantages have you experienced regarding the use of video?

Free text

What disadvantages have you experienced regarding the use of video?

Free text

Would you use the technique again if given the chance? (Circle your answer)

Definitely not 1 2 3 4 5 Definitely yes

TECHNICAL ASPECTS

Did you experience technical problems? (Circle your answer)

Yes No

How did you find the quality of the image? (Circle your answer)

Very poor 1 2 3 4 5 Very good

How did you find the quality of the sound? (Circle your answer)

Very poor 1 2 3 4 5 Very good

PRACTICAL ASPECTS

What do you think is a feasible number of videos to record during the study period?

Free text

Do you think it's feasible to integrate videos into the training? (Circle your answer)

Not feasible at all 1 2 3 4 5 Definitely feasible

Did you feel that the time it took you was worth what you got out of it? (Circle your answer)

Not at all 1 2 3 4 5 Completely

EMOTIONAL ASPECTS

Did you enjoy working with video? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Did you find it pointless to work with video? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Did you find the camera intimidating? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Were you always aware that you were being filmed? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Did you find it embarrassing to record yourself on video? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Were you stressed about using the video for yourself? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Did you feel that the video footage accurately portrayed your performance? (Circle your answer)

Not at all 1 2 3 4 5 Completely

REVIEWING YOUR OWN VIDEO FOOTAGE

How useful did you find reviewing your own video for your training? (Circle your answer)

Not at all 1 2 3 4 5 Completely

How useful did you find video for identifying your own strengths? (Circle your answer)

Not at all 1 2 3 4 5 Completely

How useful did you find video for identifying your own areas for improvement? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Did you feel that your learning was enhanced by video? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Did the videos have an impact on your clinical practice? (Circle your answer)

Not at all 1 2 3 4 5 Completely

Thank you for your feedback!

Interview guide

General

What was your experience with using video?

Can you provide some more explanation for your answers on your end form?

Optionally: Your questionnaire indicates that you would/would not (according to participant questionnaire) use video in your further education. Can you elaborate more on your answer?

Are there any other aspects you would like to add to the advantages and disadvantages you noted in the end form?

Optionally include notable points from the online survey.

Technical aspects

Are there any issues regarding the technical aspects that you would like to discuss?

Optionally include notable points from the online survey.

Practical aspects

You indicated that you find video feasible/not feasible (according to participant questionnaire) in the education. Can you provide more explanation why you gave that answer?

You indicated that the time investment in video is worth/not worth it for what you will gain (according to participant questionnaire). Can you provide more explanation why you gave that answer?

Are there any other aspects you would like to add regarding practical aspects?

Optionally include notable points from the online survey.

Emotional aspects

Can you provide more explanation for the answers you gave regarding the emotional aspects?

Optionally include notable points from the online survey.

Reviewing own video footage

Did you find watching your own video useful/supportive/informative for your own education?

For which competencies did you find this particularly useful or not useful?

Did you have a different impression of your own actions after watching your own video? If yes, in what way?

Are there any other aspects you would like to add regarding reviewing your own video footage?

Optionally include notable points from the online survey.

Miscellaneous

Are there any other matters you would like to discuss about this study?

SUPPLEMENTARY FILE 4: CODEBOOK INTERVIEWS

1. INTERNAL FACTORS

A. Strengths

- Evolution and follow-up possible
- Impact on resident's behaviour
- Objective medium for feedback
- Others can observe too
- Provides a truthful representation
    - Why - Afterwards selection of moment
    - Why - Camera integrated in the room
    - Why - Forgot about camera
- Provides novel insights
    - Audio
    - Comparing pre and post video
    - Looking at others
    - Looking at yourself
    - Looking from different perspectives
    - Rewatching is possible
- Stimulates learning
    - How - Confirmation of strengths
    - How - Fosters self-reflection
    - How - Insights in areas for improvement
    - More positive feeling afterwards
- Suits different purposes
    - Suitable for multiple competencies
    - Suitable for multiple situations

B. WEAKNESSES

- Being aware of the camera
- Impact is limited
- Technical issues
    - Limited retention in time

    - Not every angle is available
    - Problems with sound
    - Reviewing cannot be done everywhere
    - Technological competence
- Watching or listening to yourself
    - Critical for oneself
    - Don't like doing this
    - Fear of errors being pointed out
    - Stress for reviewing

2. EXTERNAL FACTORS

C. OPPORTUNITIES

- Feedback in two ways
- More frequent use might have more impact
- More insights as younger trainee
- What optimises time investment
    - Automatic recording
    - Easily set up
    - Feedback beforehand
    - Integration of form in ePortfolio
    - Providing practical help
    - Selecting parts
- What stimulates use
    - Having material readily available
    - Having sufficient to reflect on
    - Integration in resident training
        - (Linked to) a mandatory task
        - Accustomisation
        - Dedicated time available
        - General teaching moment
        - Initiative by supervisor
        - Not considered an extra

        - Systematic use
    - Looking back when it suits you
    - Positive experience
    - Providing reminders
    - Watching by yourself

D. Threats

- External stimulus is needed
    - Motivation = helping the study
- Feeling of excess work
- Feeling uncomfortable
- Frequency of events to record
- Learning saturation
- Need for informed consent
- Privacy of patients in a shared room
- Requiring active consideration
- Time constraints
    - Additional steps
    - Anticipated duration unknown
    - Making it a priority
    - No dedicated time available

Chapter 7: General discussion

"Why waste time proving over and over how great you are, when you could be getting better?"

Carol S. Dweck

This dissertation aims to provide insights in how to optimise workplace learning (WPL) in postgraduate medical education (PGME) in order to support residents and supervisors in learning during daily clinical practice. The general introduction in **Chapter 1** provided an overview of the history and current practices in the WPL context in Flanders. Workplace learning in PGME is essential for residents to become competent in the medical profession. Although WPL has received specific attention within medical education research, research within PGME, and specifically in the Flemish context, remains less represented in literature. This Flemish context is important, as it provides a unique PGME setting with the dual learning path between WPL and the Master of Specialistic Medicine (MSM). Transferability of knowledge from other research has a certain potential, but even then, its applicability needs to be tested and evaluated in the context where it is applied.

Chapter 2 elaborated on the research objectives, which were specifically aimed to answer current knowledge gaps for Flemish WPL in PGME. In the next sections, the main results for each research objective, which have been presented in **Chapters 3 to 6**, will be summarised.

After that, the current chapter aims to provide recommendations that are derived from the results of the previous chapters. After each recommendation, these emerging issues and critical reflection upon it will be discussed. The discussion will continue with methodological considerations in the limitations section, opportunities for future research and a general conclusion.

1. Main results

Research objective 1

The construct of WPL in PGME has significantly changed in the last century. This shift can be attributed to the general rapid expansion of medical knowledge and technology, changes in residents' working hours and working conditions, increased research into learning methodologies, and so forth.[10,85] While many of these changes have enhanced WPL, there remains ample opportunity for further optimisation. The conduction of WPL in PGME is influenced by many factors, such as time spent in the hospital, the balance between working and learning, patient exposure, supervision and guidance from several healthcare professionals, and the provision of a clear WPL curriculum. To effectively harness the potential of WPL in the unique Flemish context, a deeper and evidence-based understanding of its

operational dynamics is essential. This understanding will enable the alignment of educational strategies with the specific needs of Flemish residents and supervisors, and opportunities inherent in WPL. Thus, the research gap was addressed in the following research objective:

Research objective 1:

To identify the main enablers and challenges of residents and their supervisors, involved in the training of hospital specialists across different medical specialties and clinical teaching departments.

Focus group discussions were conducted in which residents and supervisors discussed enablers and challenges they encountered in WPL in online focus group discussions. These results are presented in **Chapter 3**. Three themes emerged: dual learning path, feedback, and supporting the learning process. The first theme, the dual learning path, contained the balance between WPL and the MSM curriculum. It showed that both are valuable, but that the current balance and complementarity between the two is not yet optimal. This was due to time constraints, unclear training objectives, and an unclear structure limiting the possibilities for a personalised trajectory adjusted to the residents' needs. Specifically for WPL, being actively involved in various aspects of the job was an enabler, but this was in contrast to the challenges of the imbalance between working and learning, and the lack of an educational culture at the workplace.

The second theme was feedback in WPL. There were opposing answers from residents and supervisors regarding quantity and responsibility for initiative taking: residents found they received little feedback and wanted supervisors to give more feedback spontaneously, while supervisors indicated they provided a lot of feedback but that residents asked for it infrequently. Residents found the quality of feedback variable. Surprisingly, supervisors wanted more feedback from residents towards them, while residents indicated that they seldom found an opportunity to engage in these two-way feedback conversations.

The third theme, supporting the learning process, had three subthemes related to different actors. The first subtheme was the support of residents' own learning, often referred to as self-directed or self-regulated learning. Although it was perceived as important by both parties, supervisors indicated that these skills are not mastered by residents and that they lack

information on how to provide guidance to foster these skills. Residents indicated that self-reflection, a key element of self-regulated learning, is complicated by a lack of external input, for instance the previously discussed feedback that is missing. The second subtheme was supervisors' guidance, which showed several enablers and challenges opposing each other: residents being considered as colleagues versus a strict hierarchical structure, and many or few moments of direct observation of residents, progressively becoming independent versus an inappropriate amount of responsibility. This illustrates the variety in how WPL is constructed, even within a small region as Flanders. Another challenge is that supervisors lack protected time for educational activities. The third subtheme was support of the learning process by the ePortfolio. This was specifically asked for in the focus group discussions, aligning with the context of this dissertation, which is embedded in the SBO Scaffold project. This project aimed to develop an ePortfolio for healthcare disciplines to support learning. The results of the focus group discussions suggested that the current ePortfolio might stimulate learning conversations, but that most residents considered it a logbook instead of a tool to support the learning process.

RESEARCH OBJECTIVE 2

There has been a shift from time-based education to competency-based education in the 1960s, a shift that mirrored developments in industry and higher education in general. [53,55,56,59] Competencies can provide a more reliable and transparent means of holding medical education accountable. This can ensure that every graduate is fit for practice with a focus on outcomes related to patients, populations and health professions education programs.[53,54,57,58] Currently, there is a concurrent use of different competency frameworks, which is complex and confusing. There is a lack of an integrated framework that encompasses both the overarching outcomes of the MSM curriculum and those specific to the paediatric specialty. Moreover, there is a notable absence of alignment with the framework used in undergraduate medical education (UGME). Thus, the research gap was addressed in the following research objective:

Research objective 2:

To develop and validate an integrated competency framework for postgraduate paediatric training.

Chapter 4 contains the results of a Delphi study which validates an integrated competency framework. This framework was based on the frameworks of CanMEDS, European Union of Medical Specialists (UEMS), and MSM. The general competencies were supplemented with discipline-specific competencies. Two of these specific competencies, the medical knowledge and medical skills inherent to the paediatric profession, encompassed a separate list that can be adapted according to local and current needs. These separate medical knowledge and skills lists help adopt a holistic curriculum perspective, which avoids focusing exclusively on discipline-specific medical competencies.

RESEARCH OBJECTIVE 3

Video review, which involves the analysis of residents' clinical practices through recorded footage, fosters reflection and feedback by enabling both residents and supervisors to revisit events exactly as they unfolded.[102,103] It seems to be a feasible, commonly used learning tool, but current literature lacks a comprehensive review of its impact on learning in PGME in settings where cameras are not routinely part of clinical care. Thus, the research gap was addressed in the following research objective:

> **Research objective 3:**
>
> To examine the contemporary body of literature assessing the educational efficacy of video review in PGME.

The results of the systematic review in **Chapter 5** showed that all studies investigating the learning effect of video review found a positive effect. Four studies had outcomes related to knowledge and skills. Five studies reported learning effects on behaviour, and only one study reported on the impact on patient outcomes. Altogether, only 11 studies have been conducted in over 40 years that specifically address this research question in the context of clinical practice in PGME, where cameras are not routinely part of care. The studies were heterogenous in design, which complicates the formulation of clear recommendations for video review in PGME.

RESEARCH OBJECTIVE 4

Within PGME in Flanders, there exists a notable absence of studies evaluating how video review can facilitate reflection during WPL in PGME outside of simulation settings. Thus, the research gap was addressed in the following research objective:

Research objective 4:

To investigate the feasibility of video review and its effect on self-reflection for residents in a neonatal intensive care unit (NICU).

Chapter 6 provides insights into the interventional study evaluating video-assisted self-reflection for residents in a NICU. Residents had overall more self-reflection fragments after video-review. The results indicated that video review improved self-reflection by confirming strengths, offering enhanced insights into areas for improvement, and stimulated to formulate key take-home messages. Despite an increase in points of improvement, residents were not less satisfied with their actions after video review. The residents had a positive experience with video-assisted self-reflection and found it feasible to structurally integrate it into practice. Various factors facilitating or hindering the future integration of this approach in practice were identified, such as residents getting accustomed to video review, providing dedicated time, and adherence to privacy regulations.

2. LEARNING DURING RESIDENCY

WORKING VERSUS LEARNING IN THE WORKPLACE

Recommendation 1

Optimise the available time for residents in the hospital with sufficient learning opportunities

Suggestions to achieve this:

- Alternate busy clinical rotations with educational activities, such as time for reflection, time for self-study and opportunities to observe expert professionals.

- Reshape the financial model of residency

- Lower the administrative burden

- Delegate a selection of tasks to other healthcare professionals, such as a clinical nurse specialist

Since ancient times, the profession of medicine has been taught in the workplace. This is needed to truly understand medicine and to become a competent physician. Although a high exposure to clinical practice is essential, we need to be cautious for overexposure and exploitation. For optimal learning, the resident cannot be seen as a cheap labour force to keep the hospital up and running without sufficient learning opportunities.[10,21,230] The focus group discussions in **Chapter 3** indicate that residents regularly found an imbalance between working and learning, and they perceived a lack of an educational culture in many departments.

However, a good balance between working and learning is pivotal because less time for learning leads to residents adopting a surface learning approach.[36,81] In contrast, a deep approach to learning involves the processing of experiences, which is essential for giving meaning to what has happened.[82] This method facilitates to retain information with the proper context over time.[82] The deep learning approach can be achieved by engaging in self-study, reflection and feedback practices, following specific courses, and so forth. However, implementing an educational culture through these activities requires time. The results of the focus group discussions revealed numerous time constraints during WPL in Flanders, which affects learning in the workplace.

One influence on these time constraints is the amount of time residents spend in the workplace. Working hours have been reduced throughout the last decades, transitioning from practically living in the hospital to an average of 60 hours per week.[22] This reduction has faced criticism from supervisors who fear a compromise in residents' competence; however, studies have found no such evidence.[22,231,232] On the contrary, there is evidence suggesting a negative impact of high working hours on the quality and safety of patient care.[23,24,233-235]

Upscaling the working hours to increase exposure is not a good option. However, we can still influence the time constraints by changing how residents spend their time in the hospital, offering more educational activities rather than focusing solely on productive clinical care.[236] This task is unfortunately complicated by the fact that residents are costly for clinical departments. In Flanders, the payment of residents is only regulated by the government for a small part, with supervisors receiving relatively modest compensation for the time spent in guiding residents.[44] Furthermore, despite the conditions attached to receive this

compensation, there is no monitoring of how the funds are being spent. Consequently, the funding does not guarantee increased educational activities, which highlights the need to differentiate hospital priorities from educational priorities.[36]

Besides the compensation, clinical departments bear the primary responsibility for covering residents' wages. In the current Belgian healthcare system, which operates on a payment-per-patient-visit and per-clinical-action basis, this often entails the resident to conduct a sufficient number of patient visits and clinical activities to financially contribute to the department.[27] There are several arguments in favour of allowing residents to engage in such productive work, including the importance of learning how to work under pressure, developing time management skills and gaining sufficient clinical exposure.[237-239] Furthermore, a study in the Netherlands has demonstrated that these typically less strictly supervised practices have a significant financial impact and thus seem necessary for covering residents' costs.[237] However, the pressure to complete sufficient productive work to be financially productive undoubtedly constraints the opportunities for adopting a deeper learning approach.[27,82] When residents engage in repetitive tasks without adequate challenges, or opportunities for reflection and case discussions under the guidance of a supervisor, this comes at the expense of their education. Additionally, the considerable administrative burden of clinical work often proves to be of limited educational value.[33-35]

Upon reviewing the literature, it becomes evident that the financial structure of residencies varies among countries.[240] In the Netherlands, for instance, the government covers residents' wages and allocates an educational budget for residents to reimburse mandatory training activities.[240,241] This different funding system results in differences in the educational systems, affording residents more time for learning and supervisors more time for teaching. However, it is imperative to exercise caution before simply replicating such a system in Flanders. This caution stems from the fact that many Dutch residents undergo a period of clinical experience without being formally enrolled in medical specialist training ('Arts Niet In Opleiding tot Specialist', ANIOS), while residents in Flanders experience a smoother transition from basic medical training to residency.[242] Nevertheless, implementing substantial governmental funding, coupled with oversight on how the educational budget for residents is allocated, would probably present a necessary step in improving resident education in Flanders.

Another exacerbation of the time constraints can be linked to the administrative burden. Residents are frequently tasked with extensive documentation in electronic health records, with workflows often being suboptimal, resulting in significant time consumption.[33-35] The literature indicates that a substantial part of residents' hospital time is dedicated to documentation and administrative tasks, which was also found in the study in **Chapter 3**.[33,34] Potential pathways to gain time during WPL are investing in efficient workflows of electronic health records, providing education on residents' management of administrative duties, and reducing unnecessary documentation requirements. This gained time could then be allocated to educational activities.

Another option to optimise the balance between working and learning is emerging through the introduction of clinical nurse specialists or advanced practice nurses. These nurses are increasingly becoming part of healthcare professional teams, and they are assigned specific responsibilities to streamline healthcare operations.[243] By reallocating clinical duties among healthcare team members, time could be freed up for residents and supervisors to focus on educational activities.[244] However, to establish this comprehensive collaboration, it requires engagement from all stakeholders, including patients, families, healthcare personnel, institutional leaders, and policymakers.

MASTER OF SPECIALISTIC MEDICINE

Recommendation 2

Strengthen the complementarity between the WPL and the MSM curriculum

Suggestions to achieve this:

- Provide sufficient options to individualise the MSM trajectory according to the residents' needs and interests.

- Provide a clear overview of the complementarity between WPL and the MSM curriculum.

- Provide an integrated competency framework with clear links between the curriculum and the courses.

Another theme in the focus group discussions in **Chapter 3** involves the balance between WPL and the MSM curriculum. First introduced in 2009, this Advanced Master program is the

theoretical counterpart of the practical WPL in residency. A Belgian law describes the inseparable connection between the theoretical and practical components of training.[44] The licensing committees require both the title of MSM and yearly reports of WPL before granting independent medical specialist licensure.

Although the UEMS stipulates the necessity of theoretical and practical instruction in European residencies, and the ACGME mandates regularly scheduled didactic sessions in the United States, there is no international requirement for an additional Master's training alongside residency training.[15,245] This implies that the MSM in Belgium is a unique benefit of PGME for theoretical training in residency, compared to other regions. Residents must acquire more than medical expert competencies; communication, leadership and conducting scientific research are other vital competencies that are not easily deeply instilled in the workplace.[246-249] The MSM curriculum has introduced elements addressing all of these competencies, acknowledging the relevance of such an integrated competency-based curriculum.

Despite the intended complementarity between the WPL and MSM curriculum, the focus group results in **Chapter 3** revealed a disconnect. Many residents viewed the bulk of the MSM curriculum as burdensome and sometimes even irrelevant. Courses and training related to the MSM were often criticised for their lack of flexibility and perceived insufficiency. To optimise this complementarity, two initiatives could be implemented. First, there is a need to individualise MSM trajectories. Not all residents have the same competencies and interests, and the requirements of their specific specialties also differ. This makes it impractical to outline a one-size-fits-all curriculum for every resident across all specialties.[150] Offering personalised trajectories addresses the need for flexibility highlighted in the focus group discussions and is also necessary when implementing CBME. It may reduce the perception of the MSM as burdensome when it aligns more closely with residents' individual needs.

> For example, a radiology resident who needs to do a task on hospital malnutrition or a forensic resident writing a paper about rheumatoid arthritis is not ideally aligned with their training objectives.

Currently, an interuniversity workgroup consisting of members of faculty and members of the Flemish Association for Medical Specialists in Training ('Vlaamse Vereniging voor Arts-

Specialisten in Opleiding', VASO) is working to streamline the MSM curriculum between universities. A standardised curriculum will optimise the curricula and foster the exchange of residents between universities. Both could potentially enhance the possibility to tailor the trajectory of the MSM to residents' needs.

Second, the courses of the MSM should aim to teach the outlined objectives. This is another issue that has emerged from the focus group discussions in **Chapter 3**, where the alignment between the competencies outlined in the MSM curriculum and the proposed courses was not always evident. The current MSM curriculum consists of four adapted roles (medical expert, researcher, communicator, manager) instead of the original 7 CanMEDS roles.[12,77] These roles encompass a limited list of general competencies applicable across all medical specialties, such as 'possessing necessary specialised knowledge and understanding', 'participating in scientific research' and 'exhibiting professional behaviour within the usual ethical norms'.[78] These competencies are rather abstract which makes it challenging to address them within formal MSM courses, complicating their design. Furthermore, when residents lack a clear understanding of both the WPL and MSM outlined objectives that should be achieved, they struggle to identify beneficial courses for their trajectory, complicating the individualisation efforts mentioned previously. Enhancing the connection between the competencies and the proposed courses may be possible through a clear formulation of competencies. This requires the development of an integrated competency framework.

The ultimate goal is to achieve perfect complementarity between the curricula of WPL and MSM, eliminating any distinction between the two. This aligns with the holistic view of the competency framework, which defines a competent physician as someone who has acquired knowledge, skills, and attitudes across all domains. By integrating theoretical and practical training without distinction, we can create an ideal educational pathway for future medical specialists.

QUALITY OF TEACHING

Recommendation 3

Enhance didactic competencies of all physicians somehow engaged in residency

Suggestions to achieve this:

- Mandate train-the-trainer courses for every physician working in a department with residents

- Integrate didactic competencies more specifically in residency

- Stimulate proficiency in didactic competencies by stimulating resident-to-supervisor feedback and/or anonymous quality evaluations

The quality of teaching is another crucial aspect of learning in residency. The discussion of **Chapter 3** focused on supervisor's feedback and guidance capabilities, alongside the absence of an educational culture, which might also be related to the didactic competencies of supervisors. However, these didactic competencies cannot be assumed, particularly in unpredictable and complex learning environments such as clinical settings.[18] Very few clinicians have had formal instruction in the theory and execution of effective teaching, especially in the specific context of adult learning.[250] Despite the recently introduced legal requirements for official residency supervisors ('stagemeesters') to follow a formal training programme (train-the-trainer courses), these courses are poorly defined within current legislation.[44] They lack quality assurance measures and clear criteria for assessing didactic competencies. Furthermore, physicians within the same department as the official supervisor, but not affiliated with the university, are not subject to the same obligations, despite that they also provide guidance to residents.[44] This lack of quality assurance underscores deficiencies within existing laws, as teaching skills significantly impact the perceived quality of clinical supervision.[251] Mandating interactive train-the-trainer courses for every physician working in a department with residents could potentially improve teaching skills and training methods. This is already mandated for residency programs in the Netherlands.[252]

Initiatives in Flanders are already taken to measure the quality of didactic competencies among supervisors. The interuniversity residency evaluation *('ABC (Aanbod, Begeleiding, Context) bevragingen'*) anonymously assesses the quality of didactic skills of supervisors per

department, among other questions related to the quality of residency training. Similar evaluations in other contexts include the Maastricht Clinical Teaching Questionnaire (MCTQ), System for Evaluation of Teaching Qualities (SETQ) and Evaluation and Feedback for Effective Clinical Teaching (EFFECT), all of which provide anonymous feedback to supervisors.[139,253,254]

Anonymity is often required due to concerns of power imbalances and retaliation.[255] The receptiveness of supervisors for resident feedback can also influence the maintenance of anonymity in these questionnaires, as reflected in the results of the focus group discussions in **Chapter 3**: residents often felt unable to provide feedback directly to supervisors. Conversely, supervisors addressed a desire for feedback from residents in that same study. Research indicates that non-anonymous feedback offers several advantages, such as that feedback is given timely, that feedback is acted on by the supervisor, and that supervisors become more approachable.[255] These benefits are more challenging to achieve with anonymous questionnaires but rely on fostering an open and constructive feedback culture, which is not present in every clinical department.[255] The anonymous and systematic evaluations, such as those conducted in the Flemish interuniversity evaluations, also have an advantage: they are able to examine teaching skills at a broader level, to identify more general deficits and to use this information to enhance supervision within each department.

Optimising the quality of teaching is crucial for future practice: those residents who fail to appreciate the value of training may be less inclined to implement qualitative training methods as they progress to senior roles.[27] Given that many physicians will eventually assume mentoring roles, either with residents or students, prioritising the optimisation of the learning process is essential to ensure the delivery of high-quality educational experiences for future generations.[256,257] This raises the question: if almost every physician takes on a mentoring role at some point of their career, should proficiency in teaching then be a graduation requirement? This idea is at least implied in the competency framework that was validated in **Chapter 4**.

3. Integration of competencies

Recommendation 4

Design a clear competency framework that is easily adopted in daily clinical practice to support learning for and assessment of residents

Suggestions to achieve this:

- Involve all stakeholders, residents included, in the design of a competency framework

- Consider the integration of EPAs, with careful design and implementation in WPL according to the latest evidence

COMPETENCIES

Competencies are essential in the recent shift towards CBME in PGME, a shift reflecting broader developments in industry and higher education.[53,55,56,59] After identifying the abilities needed of graduates in the specific local context, it is imperative to explicitly define the required competencies and their components (knowledge, skills and attitudes).[62]

The findings from the focus group discussions in **Chapter 3** revealed that residents are sometimes unaware of the used competency framework within their particular discipline. Other residents indicated that it was complicated and confusing to use both the general competency framework from the MSM alongside the discipline-specific competency frameworks used during WPL. This complexity is not exclusive to residents; supervisors also encounter similar challenges. Consequently, this served as the impetus for developing an integrated competency framework for paediatric residency and validation of it through a Delphi study, which is presented in **Chapter 4**.

The Delphi study was conducted with 5 expert groups, one of which consisted of recently graduated residents. There is a growing body of literature on student participation in the design of educational practices. Students' role transitions from the classical reactive stance of evaluating the taught curriculum to a proactive engagement, by bringing in their own ideas and concepts and being directly involved in decision making processes.[258] Studies indicate that this participation can lead to innovative curricular changes and precious insights in how a curriculum is experienced.[259,260] The participating students, the residents in PGME, benefit through the acquisition of non-medical competencies such as professionalism, management,

self-directed learning, teaching and fostering innovation.[259,261] Therefore, we advocate for the routine involvement of residents when reshaping curricula in PGME, fostering its quality and innovation.

As discussed in **Chapter 4**, the validated competency framework in our study represents an important first step in curriculum design, yet currently lacks practical applicability. The list of competencies is extensive and their formulation rather abstract, potentially hindering effective assessment.[258] Therefore, further refinement is necessary before elaborating this framework into a WPL curriculum.[157] To fully implement the competency framework within a CBME curriculum, three additional steps are required: (1) define milestones along a development path; (2) select appropriate educational activities, experiences and instructional methods, and (3) choose suitable assessment tools.[62]

MILESTONES

The principles of CBME underscore learner-centeredness, facilitation of personalised programs tailored to individual needs, and a progressively structured approach stimulating continuous growth during residency.[56-58,60,62,64,66] This advancement can be facilitated by delineating milestones that must be achieved throughout residency. Milestones consist of educational statements designed to chart a logical trajectory of professional development across essential competency elements.[73,262] Such milestones provide crucial guidance for entrusting residents with increasingly independent tasks and expanding their responsibilities in patient care.

However, the results of the focus group discussions revealed a discrepancy between assigned responsibilities in patient care and residents' capabilities. Some residents find themselves under-challenged as they are capable of more than they are permitted. Others feel compelled to exceed their capabilities and work independently before they feel adequately prepared. Although the concept of 'learning by doing' is often used to justify the latter, its compatibility with patient safety is debatable when residents have not yet attained the required competency level.[18] However, including unsupervised practice in resident training is essential. It helps residents face the boundaries of their knowledge and gain independence, preparing them to handle challenges autonomously before graduation. This could ultimately improve patient safety after graduation.[43] Currently, such a milestone system is not integrated into

residencies in Flanders, which may be one explanation why many residents feel they are working well under or beyond their capabilities.

ENTRUSTABLE PROFESSIONAL ACTIVITIES

Milestones were integrated mostly in Northen America, as the ACGME implemented these in several specialties.[262] However, critique came that milestones are still a descriptor of a good physician, and that it is difficult to translate resident's specific behaviours during patient care into such a descriptor.[263] Alternatives were sought, and potentially found in the development of entrustable professional activities (EPAs). These are professional activities that residents (or other students and professionals in diverse healthcare professions) can be *entrusted* with.[258] They are not an educational concept, but rather structured descriptions of professional work that are mapped to competencies and/or milestones, making the latter less abstract and therefore hold significant face validity for workplace supervisors.[73-75] According to Englander and Carraccio, the objective of EPAs is to equip supervisors with the necessary information and resources to transition from "*I'll know it when I see it*" to "*I'll know what's important for the learner to perform, I'll know what specifically to look for so I can recognize it when I see it, and I'll be looking for and recognising the same thing as my colleague.*"[75] The same could be true for residents wanting to set up learning goals and perform adequate self-reflection. However, for EPAs to be effective, clear descriptions of competency levels are needed with defined performance indicators, stimulating different assessors to use the same language.[75] Without this clarity, EPAs risk facing the same criticism as competency lists, especially if they are overly abstractly formulated, potentially negatively impacting the assessment potential.[150,258,264]

Nevertheless, when taking the guidelines described in the literature into account, the development and integration of EPAs would be a next step forward in optimising PGME in Flanders, as this responds to the current lack of clear frameworks and the lack of clarity in entrusting residents with independent tasks aligned with their acquired competencies. It would also provide a structured overview of residents' progression from a novice entering residency, to an entrusted healthcare provider when graduating.

4. Integration of video technology

Recommendation 5

Facilitate the integration and investigation of video review in residency for learning purposes

Suggestions to achieve this:

- Perform more studies investigating the learning effect of video review

- Design a concise self-reflection form and prompt to reflect on strengths first

- Ensure familiarity with a first positive experience and make dedicated time available to review the video

- Provide a legal framework that facilitates the use of video recording with sufficient protection for all involved stakeholders

Video-assisted self-reflection

The next step in the development of CBME is the selection of educational activities. Specifically in this dissertation, there was a focus on the use of video recordings. The use of video review in medical education has been reported since the 1960s.[100] Recording residents during clinical care yields videos that capture their actions within an authentic context. This can support the resident's reflection practices by minimising the discrepancy between their perceived performance and their actual performance. As the learning events can be recalled in a realistic context, the identification of previously missed aspects is enabled.[98-103]

However, to integrate video review in the best way, it is essential to understand what the effect is on learning. Systematic reviews have been performed on the learning effect of video review in UGME, simulation settings and endoscopy settings in PGME.[100,106,109-111,184-186] The results of studies conducted in UGME are difficult to transfer without additional investigations, since the learning patterns and context are different in PGME. Certain recommendations from UGME and simulation settings may not be feasible in PGME, such as extensive debriefing sessions, given the time constraints inherent in busy clinical environments. Next to this, studies in specialised fields like endoscopy often narrow the focus of videos to internal medical expert procedures, limiting insights into other competencies such as communication. The presence of a camera potentially has an impact on those who are being recorded, an effect that diminishes over time.[187] Therefore, the routine presence of

cameras in some clinical settings could have presented a different learning effect than in environments without standard camera use.[187]

Thus, there was a need for a comprehensive review on the learning effect in PGME in clinical settings where a camera was not routinely integrated into practice. **Chapter 5** encompasses the results of the systematic review in that specific setting. Although all included studies were positive regarding the learning effect of video review, only 11 studies in PGME fitted the inclusion criteria. They had heterogeneous designs, which complicated a comprehensive analysis and describing guidance for future use of video review. Many feasibility studies were excluded, and although they were valuable, they did not sufficiently address how and why video worked, its impact on various competencies, optimisation strategies, and its ideal integration into busy WPL curricula. This is why more studies are needed to have more insight into the how and why of this valuable tool.

In **Chapter 6**, a pilot study was performed that focused on the effect of video review on self-reflection, a crucial aspect of fostering residents' self-regulated learning skills.[91] These skills are vital in medical education, facilitating continuous growth and adaptation to new medical developments even beyond formal training. Our findings suggest that video review enhances self-reflection, as evidenced by positive outcomes.

The pilot study implemented a structured self-reflection form, administered both before and after video review to avoid measuring the impact of the form itself. Interestingly, residents reported an increase in strengths post-review, despite initially focusing on personal learning areas for improvement. This discrepancy raises questions about their intentions and the influence of the self-reflection form's format on their behaviour. Additionally, while video review led to more identified areas for improvement, residents remained satisfied with their performance. Further investigation is needed to understand the generalisability of these findings and the underlying factors driving this behaviour.

Further investigation is also needed to evaluate the impact of video-assisted self-reflection on a higher level of impact on learning. The model of Kirkpatrick classifies learning outcomes and assesses the effectiveness of interventions.[188] Measuring self-reflection could be interpreted as a Kirkpatrick level 2 effect, assessing the intervention’s impact on the resident. It can be assumed that it indirectly has an effect on the resident's behaviour in clinical practice

(Kirkpatrick level 3) and ideally positively benefits patient and healthcare outcomes (Kirkpatrick level 4).[188,221] However, we did not investigate these effects directly and assumption is insufficient in research to advise policy changes. Therefore, resources need to become available to investigate the implementation of a video-assisted self-reflection tool on Kirkpatrick levels 3 and 4.

ROUTINE INTEGRATION IN RESIDENT EDUCATION

Reflection ideally aligns with a standard framework containing competencies or EPAs. In the pilot study in **Chapter 6**, residents were free to reflect on any aspect they deemed relevant, leading to limited variability in self-reflection regarding competencies. It is impossible to distinguish whether other competencies were not observable in the videos, or whether residents did not observe them as they were not prompted to in the study's self-reflection form. While interviewees appreciated the form's brevity, future research could explore the necessity and value of referencing to an existing framework.

Additionally, residents' desire for group discussions mirrors the principles of video reflexive ethnography (VRE), a collaborative visual methodology used to understand and optimise team practices.[265] While VRE focuses on group dynamics, similar principles could apply to group analysis of resident performances. However, constructive discussions are vital to prevent undue stress and confidence issues during video review sessions. This possibly requires an experienced moderator to lead the discussion and stimulate constructive feedback.

All participating residents in the video study found the integration of video in their residency training feasible. However, defining the process is imperative. While each PGME context varies, guidelines on video review in clinical practice could offer valuable insights. Such guidelines could cover logistical aspects like recording tips, video management, and review procedures, as well as ensuring smooth consent processes and parental involvement.

Regarding the learning process, guidelines should address optimal video review frequency, optimalisation efficacy, and fostering technology acceptance among residents. Our interviews highlighted the importance of initial positive experiences with video use, which is needed for residents to become accustomed to video review which facilitates continued engagement.[101,225]

While the participating residents of the study in **Chapter 6** indicated that they found video review very valuable, time constraints were a major issue for reviewing the video and integrating the tool in their residency. Having sufficient time available is necessary for maximising the learning potential of educational activities.[36,81,82] As earlier described in this discussion, more dedicated time for educational activities, such as using video review for reflection, needs to be embedded in residency in Flanders.[236]

VIDEO VERSUS PRIVACY REGULATIONS

Many feasibility studies about the integration of video review in clinical practice have been published.[106,266,267] Although investigating feasibility is indeed important, most studies investigated the opinion from participants and provided less information about the practical implementation.

One significant practical concern pertains to aligning educational activities with regulatory laws. In **Chapter 6**, challenges arose regarding the inclusion of videos, primarily due to complexities surrounding informed consent. In some jurisdictions, videos were recorded without explicit consent under the guise of quality improvement, an exception wherein informed consent is deemed unnecessary. However, the General Data Protection Regulation (GDPR) mandates informing patients about the purpose and process of video recording, as well as its subsequent handling.[268] Given that recording inherently involves processing personal information, even without subsequent review, it was advised to always obtain informed consent.

Because WPL is inherently unpredictable, traditional methods of obtaining written informed consent before recording becomes complicated. This complexity is especially pronounced in paediatric settings, where patients may lack the capacity to provide consent, and caregivers may not always be present during clinically significant events. Moreover, obtaining consent before birth, as in the case of recordings of NLS events, presents a unique challenge. An exception for our study was possible in accordance with the data protection officer to obtain informed consent afterwards, but this remains a delicate issue to tackle.

To address these issues, we propose legislation allowing flexibility in the timing of consent acquisition. While patients should be informed upon admission that recording is possible, the option to provide official informed consent after recording, but before review, should be

explored for situations where obtaining prior consent is impractical. Robust protocols must be established to prevent video review before consent is obtained and to safeguard the privacy of all parties recorded. Technological solutions, such as secure integrated platforms, making a video only available when informed consent is obtained, and with automatic data erasure, could facilitate this process.

Furthermore, patients should have the opportunity to review their recordings, as stipulated by the GDPR. During NLS events, parents are not always present. When they are present, a lot of actions take place in a short time, which can be overwhelming. Thus, reviewing these moments can be emotionally significant for the parents. However, measures must be taken to protect the privacy and integrity of all individuals recorded, including healthcare professionals, by ensuring that recordings are not used against them in legal proceedings. The same precaution should be taken for information about the video included in a(n electronic) portfolio; reflections in a portfolio have already been used to convict a doctor in training.[269] Without confidentiality measures taken, it is possible that learners do not engage in valuable and deep reflection to avoid repercussions.[269]

In conclusion, a dedicated legislative framework is needed to optimise informed consent procedures, delineate the permissible use of videos, and safeguard the privacy of patients and healthcare professionals alike.

5. Assessment in workplace learning

Recommendation 6

Optimise feedback practices in WPL in a holistic manner

Suggestions to achieve this:

- Improve quality of feedback by enhancing didactic competencies

- Provide clearly formulated objectives to foster specific feedback

- Stimulate the use of a portfolio to collect formative assessments that can inform summative assessments

ASSESSMENT FOR LEARNING

One principle of CBME that has not been discussed yet is the execution of assessment, both of and for learning.[69] Assessment for learning tends to be formative, assessment of learning is summative.

One form of assessment for learning has been discussed in the focus groups from **Chapter 3**, namely feedback.[270] Performance feedback is inherent to WPL, and different principles of high-quality feedback are discussed in the literature.[271] Van Ostaeyen et al., who analysed written feedback within CBME, described 4 important principles of high-quality feedback: (1) specific information about the student's performance; (2) a judgment about that performance; (3) elaboration on why the performance was judged that way; and (4) guidance on how the student's performance can be further strengthened or improved.[272] The focus groups revealed that residents had the perception that feedback quality was an aspect of WPL that could be improved. One strategy could be to optimise the didactic competencies, including the provision of feedback, as previously discussed.

Even if high-quality feedback is available, we still need standards to compare residents against. This ensures that the feedback includes specific information and guidance for residents' future plans.[270,273] Without clearly formulated standards with performance indicators, feedback is an interpretation of the supervisor's subjective standards.[274] Although experienced physicians' perception can be valuable, it is of added value to have objective standards within a competency framework that is known and used for all parties as discussed earlier.[270,275] Without a clear framework, whether it is with competencies, milestones or EPAs, there are two possible consequences. First, feedback can be less specific and highly different between supervisors.[75] Although some variability is natural, it should not be contradictory. Second, feedback tends to be no longer criterion referenced but norm referenced, where residents are compared with their peers instead of objective criteria.[274,275] Thus, to optimise feedback practices in WPL, it is important to integrate these standards in residency. Here again, an interuniversity workgroup consisting of faculty and members of VASO are developing an action plan to optimise these feedback practices.

Many residents expressed interest in discussing their videos with supervisors to receive expert feedback, which aligns with the initial plan; however, implementation challenges hindered the

provision of such feedback. Previous literature suggests that guided reflection, particularly with expert input, enhances residents' understanding of their performance.[91] Video-assisted feedback offers the advantage of visual aids, fostering objective discussions that can elucidate performance nuances. Ideally, feedback should offer specific, direct insights, enabling residents to gauge their adherence to best practices accurately.[11]

Another opportunity would be to give peer feedback to each other. Peer feedback involves a mutual exchange of perspectives, allowing for different insights and learning opportunities that may not be present in the traditional supervisor-resident feedback dynamic.[135] In **Chapter 6**, residents indicated that the videos could serve as valuable learning moments when reviewed collectively in group settings. When reviewing each other's recordings, residents will discuss the learning experiences and give peer feedback, which should be constructive. Despite that peer feedback systems are not formally integrated in residencies, a systematic review by Shafian et al. indicates that peer feedback is already an important source of feedback in residency.[276] This all emphasises the importance of fostering feedback skills among residents to create a constructive feedback culture. Feedback skills will undoubtedly be important for later practice, as providing feedback to colleagues is essential for optimising continuous professional development in a safe CLE.[277]

Role of technology in assessment

Although CBME has been criticised for distracting attention from ensuring that residents are clinically competent when they complete their training, it offers clear criterion-based assessment. However, the gut feeling of experienced physicians will always be an important factor in informal assessments.[70,278] Summative decisions should therefore not be based on one assessment; the design of programmatic assessment integrates a series of individual measurements in a systematic manner.[279] Programmatic assessment aims to optimise the integration of both assessment for and assessment of learning.[280]

It is important to gather all this information in a(n electronic) portfolio. The results of the focus group discussions in **Chapter 3** showed that the current ePortfolio is stimulating learning conversations; although, it does not sufficiently support the learning process yet. Integrating all self-reflections, as those produced in **Chapter 6** after video review, feedback and other assessments from the workplace in an ePortfolio would be a first step to integrate this

programmatic assessment approach in residents' training.[281] Ideally, as programmatic assessment aims to support assessment for learning as well, this approach could lead to an increased support of the ePortfolio in the learning process.

6. LIMITATIONS

Limitations of the individual studies have been discussed in the empirical chapters (**Chapter 3 to 6**). Nevertheless, additional limitations require further examination.

The onset of the coronavirus pandemic in 2020, occurring six weeks after the start of this dissertation, significantly impacted the work and lives of healthcare workers, who were the primary focus of the research. This inevitably influenced the conduct of the studies, particularly those in **Chapter 3 and 4**, which had to be conducted online due to pandemic restrictions. The shift to an online format may have affected the dynamics of focus group discussions. Additionally, the results of the studies can potentially be influenced by the pandemic as those participating in all studies in these challenging times were either highly motivated to participate or dealt with frustrations regarding their education. Although the crisis was somewhat controlled during the execution of the study in **Chapter 6**, residual hospital measures may have still impacted residents' engagement.

Embedded within the interdisciplinary Flemish ePortfolio research Scaffold project, the focus group discussions were not solely dedicated to the research questions of this dissertation but were part of a collaborative effort involving multiple researchers. While this collaboration may have enriched discussions, it also complicated the refinement of results: questions outside the scope of this dissertation have been asked to the participants, generating information that did not fit within the proposed research questions. Additionally, the inclusion of a mixed group of residents, rather than solely paediatric residents, may have broadened the scope of information gathered but might limit the applicability of certain results to paediatric residency specifically.

Being authored by a resident midway through her paediatric residency, this dissertation reflects a particular perspective influenced by personal experiences. Despite efforts to incorporate diverse viewpoints and involve clinical supervisors as promoters, this inherent bias may have influenced the methodology, results, and discussions. Furthermore, similar to the viewpoint of “the assumption that anyone can teach is no longer deemed acceptable”,

there has been no assumption that understanding education and training happens by merely experiencing it.[18] While efforts were made to bridge this gap through educational training, the depth of theoretical understanding and its application to research may still be evolving, potentially impacting the theoretical underpinning of the research.

Lastly, this dissertation focuses specifically on PGME. To optimise WPL, greater collaboration across all stages of medical education is necessary. In a world where interdisciplinary and interprofessional collaboration is increasingly valued, research into WPL optimisation stands to benefit from a similar collaborative approach.

7. FUTURE RESEARCH

Apart from offering recommendations to optimise WPL in PGME, the results of this dissertation suggest several avenues for future research. The following section delineates potential directions for further investigation.

In **Chapter 3**, we explored the WPL needs in PGME and identified areas for future research through focus group interviews, using a phenomenological qualitative approach. Future research could gain deeper insights into current WPL needs by employing ethnographic methodologies, such as direct observation of how WPL is implemented in PGME by researchers specialised in medical education.{Cristancho, 2018 #1484} To fully grasp the concept of WPL, a mixed methods approach is required, combining different data sources and analysis methods. Research could also focus on aligning the MSM with WPL objectives and explore the benefits of interuniversity collaboration in standardising curricula; this can be either within or between specialistic disciplines, especially for the general competencies. Ideally, the division between theoretical (MSM) and practical (WPL) learning would be eliminated across all disciplines, allowing for an optimal integration that produces competent physicians.

In **Chapter 4**, the development of an integrated competency framework for paediatric residency was discussed. However, it is not yet practice-ready, thus further exploration of its integration into practice is warranted. Exploring the use of EPAs within the Flemish context, ideally in collaboration with other specialties and UGME and instances responsible for continuous professional development, is essential to ensure a true continuum from beginning to end of practice.[74,158] Additionally, further research is necessary to investigate the usability

of EPAs in practice and refine assessment practices accordingly. However, the uptake of EPAs differs across PGME programs, and it is unclear how they are practically implemented in the workplace.[150,258,264] Future research needs to further investigate the ideal implementation of EPAs in the workplace.

Next to this, the proposed recommendation of involving residents is encapsulated in the following slogan:

"Nihil de nobis, sine nobis" (Nothing about us, without us).

Studies have also indicated that student or resident participation can lead to innovative curricular changes and precious insights in how a curriculum is experienced, strengthening the recommendation for active involvement.[150,258,264] Expanding on this principle, involving patients and their families in these discussions is necessary because delivering high-quality clinical care to this group remains the primary objective of medical education.

In **Chapter 5**, the need for more studies investigating the learning effects of video review was noted. This is in concordance with the conduction of the study in **Chapter 6**, where we explored the effect of video-review on self-reflection, unveiling many options for future investigation. The exploration of these avenues encompasses various facets, ranging from refining and optimising the processes involved in self-reflection to conducting in-depth assessments of the accuracy and efficacy of self-reflection when aided by video review. Additionally, future research could focus on integrating feedback mechanisms into the video review process, providing a more comprehensive assessment of resident performance. Exploring the differences between expert and peer feedback within video-assisted learning contexts could offer valuable insights into their respective effectiveness. Moreover, aligning competencies with the use of video technology in education presents an interesting area for investigation, potentially leading to more targeted and effective teaching and assessment methods. The effect of video should be evaluated on higher Kirkpatrick levels, with ultimately evaluating its effect on patient and healthcare outcomes. Lastly, investigating how video review can stimulate learning discussions among residents could create a more collaborative and dynamic CLE within PGME programs.

In general, all future studies focusing on PGME should aim to be planned, executed, and discussed within an interdisciplinary team. During this thesis, I felt the need for interdisciplinary departments that could advise my research from the combined perspectives of medicine and education, especially regarding their intersection. A dedicated medical or healthcare education research department would enable more high-quality research in this fascinating field.

8. CONCLUSIONS

This dissertation aimed at optimising WPL in PGME. Four studies were conducted: focus group discussions to investigate residents and supervisors' perceptions of WPL; a Delphi study to validate an integrated competency framework for paediatric training; a systematic review to examine the learning effect of video review of resident performance in clinical practice; and an intervention study aimed at evaluating the effect of video review on self-reflection and the feasibility of integration in paediatric training.

The discussion formulated six different recommendations, derived from the results of the aforementioned studies and supported with a discussion of the existing literature. These recommendations were: (1) optimise the available time for residents in the hospital with sufficient learning opportunities; (2) strengthen the complementarity between the WPL and the MSM curriculum; (3) enhance didactic competencies of all physicians somehow engaged in residency; (4) design a clear competency framework that is easily adopted in daily clinical practice to support learning for and assessment of residents; (5) facilitate the integration and investigation of video review in residency for learning purposes; and (6) optimise feedback practices in WPL in a holistic manner. To integrate these recommendations into practice, efforts from all stakeholders will be needed to support residents and supervisors and consequently optimise WPL in PGME.

Summary

The training of medical specialists, also known as postgraduate medical education (PGME), primarily entails workplace learning. Workplace learning (WPL) refers to the acquisition of professional skills while actively engaging in the authentic work environment. In recent years, significant advancements have occurred in this WPL framework for residents specialising in various fields. These developments stem from the exponential growth of medical knowledge and technologies, coupled with substantial progress in educational research focused on medical training and the education of medical specialists.[10,11] In **Chapter 1**, the introduction, these developments are thoroughly discussed, along with key determinants of the quality of resident training, namely the workplace, the intended learning outcomes, and the learning process. **Chapter 2** outlines the various research objectives.

In **Chapter 3**, the first research objective is discussed. There is much literature detailing the facilitators and challenges encountered during residents' WPL. However, there was no such study specifically within the context of Flanders, where the specialist training uniquely integrates WPL with the Master in Specialist Medicine (MSM) program. Therefore, focus groups were conducted, inviting both residents and supervisors to share their perspectives on what worked well and what did not during WPL. Three themes emerged: dual learning path, feedback, and supporting the learning process. Within each theme, facilitators and challenges were identified. This dissertation primarily focuses on addressing the identified challenges to enhance WPL.

Within the theme of the dual learning path, one issue discussed was the lack of clarity regarding the competencies to be attained. Either the residents did not know an established competency framework, or multiple frameworks were in use which led to confusion. Specifically within paediatric residency, two frameworks were currently employed: the framework of the MSM, which is integrated into the electronic portfolio, and the framework for general training paediatrics established by the European Union of Medical Specialists. Additionally, the CanMEDS competency framework is predominantly used in undergraduate medical education. In **Chapter 4**, these three frameworks were systematically scrutinised and merged. Subsequently, this framework was validated through a Delphi study. Five groups of experts iteratively provided their opinions on the relevance and formulation of the competencies. Ultimately, a set of 95 competencies was validated after three rounds of the Delphi process.

Building upon the findings of the focus group discussions outlined in **Chapter 3**, it was identified within the theme of learning support that there were insufficient opportunities for direct observation, as well as challenges in fostering thorough self-reflection due to limited input. The use of video recordings could offer a potential solution to address these issues. Consequently, **Chapter 5** presents a systematic review which assessed the various ways in which video could be employed, as well as the learning effects described in current literature regarding its use during WPL of residents. The recording needed to take place within an environment where cameras are not typically integrated into routine clinical practice. Eleven studies met the inclusion criteria; all demonstrated a positive impact, yet they showed considerable heterogeneity in their designs, making it challenging to formulate general recommendations regarding the use of video in residency training solely based on this review.

Chapter 6 presents the pilot study in which paediatric residents, working in the neonatal intensive care unit (NICU), recorded a video of themselves during a clinical activity. Subsequently, these trainees engaged in self-reflection before and after watching the video using a structured self-reflection form. A comparison of these self-reflections before and after video review revealed a significant increase in the number of areas for improvement identified by the residents. However, their self-satisfaction levels remained unaffected. Additionally, residents noted proportionally more strengths than areas for improvement both before and after video review. They also found integration of video review into their training feasible.

Subsequently, the general discussion in **Chapter 7** presented several recommendations based on the findings of the preceding studies and the current knowledge available in the literature. This was followed by the limitations of this dissertation, which were critically examined and reflected upon.

Finally, there remains the reflection on whether this thesis has indeed investigated how WPL in PGME can be optimised, providing support not only to the residents but to their supervisors and supervising colleagues as well. The recommendations formulated are a step in the right direction, but further research is necessary to support this advice. Moreover, there is ample work ahead for residents, supervisors, educationalists, hospital managers, researchers and policymakers to collaboratively support the translation of theory in medical education

research into practice. Only through collaboration among all stakeholders can an optimal residency training program be achieved.

Samenvatting

De opleiding tot arts-specialist, ook wel voortgezet medisch onderwijs genoemd, bestaat voornamelijk uit werkplekleren. Werkplekleren (WPL) is het leren van een beroep terwijl men het uitoefent in de authentieke omgeving. De laatste jaren hebben er veel evoluties plaatsgevonden in dit WPL voor arts-specialisten in opleiding (ASO's). Dit als gevolg van onder andere de exponentiële ontwikkeling van medische kennis en technologieën, maar ook door een sterke ontwikkeling van onderwijskundig onderzoek dat zich toegespitst heeft op medisch onderwijs en de opleiding van ASO's.[10,11] In de introductie in **Hoofdstuk 1** wordt uitgebreid ingegaan op deze ontwikkelingen en op belangrijke factoren die de kwaliteit van de opleiding tot arts-specialist mede bepalen, namelijk de werkplek, de beoogde leerresultaten en het leerproces. In **Hoofdstuk 2** worden de verschillende onderzoeksdoelen gepresenteerd.

Een eerste onderzoeksdoel wordt besproken in **Hoofdstuk 3**. In de literatuur is veel informatie te vinden over wat er momenteel goed en minder goed loopt tijdens het WPL van ASO's. Er was echter nog geen studie die dezelfde oefening maakte voor Vlaanderen, waar er toch een unieke context is bij de specialistische opleiding door het gelijklopende traject van WPL samen met de Master in de Specialistische Geneeskunde (MSG). Daarom werden er focusgroepen georganiseerd waarbij zowel ASO's als supervisoren moesten aangeven wat voor hen goed en minder goed liep tijdens het WPL. De analyse toonde drie belangrijke thema's aan: (1) het duale leerpad tussen het WPL en de MSG, (2) feedback en (3) de ondersteuning van het leren. In alle thema's werden zowel facilitatoren als belemmeringen besproken. Om het werkplekleren te bevorderen, werd in dit proefschrift vooral ingezet op het verbeteren van de belemmeringen.

In het thema van het duale leerpad werd onder andere besproken dat er momenteel geen duidelijkheid is rond de te behalen competenties: ofwel is er geen competentiekader gekend, ofwel zijn er meerdere competentiekaders in gebruik wat verwarrend kan zijn. Specifiek voor de opleiding tot arts-specialist in de kindergeneeskunde zijn er momenteel 2 kaders in gebruik: (1) de leerresultatenkaart van de MSG, geïmplementeerd in het elektronisch portfolio; en (2) het curriculum voor de algemene opleiding in de pediatrie (Curriculum for common trunk training in paediatrics) van de Europese Unie van Medisch Specialisten (UEMS).Daarnaast is er nog het CanMEDS competentiekader, wat voornamelijk gebruikt wordt in de basisopleiding In **Hoofdstuk 4** hebben we deze drie kaders, gestructureerd onderzocht en systematisch samengevoegd. Vervolgens werd dit kader gevalideerd aan de hand van een Delphi studie,

waarbij 5 groepen van experts in een iteratief proces hun mening gaven over de relevantie en de formulering van de competenties. Uiteindelijk werd een kader van 95 competenties na 3 Delphi rondes gevalideerd.

Op basis van de resultaten van de focusgroep studie in **Hoofdstuk 3** werd in het thema van leerondersteuning vastgesteld dat er te weinig mogelijkheden waren voor directe observatie, alsook moeilijkheden voor grondige zelfreflectie doordat er te weinig input was. Het gebruik van video opnames zou hiervoor een geschikte oplossing kunnen zijn. Daarom werd er in **Hoofdstuk 5** een systematische review uitgevoerd om te evalueren op welke manier video ingezet kan worden, en welke leereffecten er worden beschreven in de huidige literatuur omtrent het gebruik van video opnames tijdens WPL van ASO's. Dit alles in een context waar camera's geen deel uitmaken van de reguliere dagelijkse klinische zorg. Er voldeden 11 studies aan de inclusiecriteria; ze toonden allen een positief effect, maar waren erg heterogeen in hun opzet waardoor het moeilijk was om op basis van deze review algemene aanbevelingen te formuleren over het gebruik van video tijdens de opleiding tot ziekenhuisspecialist.

Hoofdstuk 6 bevat de pilootstudie waarbij ASO's kindergeneeskunde, werkzaam op de afdeling neonatale intensieve zorgen (NICU), een video opname van zichzelf maakten tijdens een klinische activiteit. Hierbij deden de ASO's aan zelfreflectie voor en na het bekijken van deze video aan de hand van een gestructureerd zelfreflectieformulier. Het vergelijken van deze zelfreflecties voor en na het bekijken van de video toonde dat er een significante stijging was in het aantal werkpunten dat aangegeven werd door de ASO, maar dat de tevredenheid over zichzelf hierbij niet verminderde. Daarnaast waren er in verhouding zowel voor als na het bekijken van de video meer sterke punten dan werkpunten. De ASO's vonden de integratie van het herbekijken van video's in de opleiding haalbaar.

Vervolgens werden in de algemene discussie van **Hoofdstuk 7** enkele aanbevelingen gedaan die gebaseerd werden op de resultaten van de voorgaande studies en de huidige kennis die beschikbaar is in de literatuur. Hierna werden ook de beperkingen van het proefschrift, die nog niet besproken werden in de empirische studies, kritisch bekeken en werd hierop gereflecteerd.

Tot slot rest er nog te reflecteren op de vraag of dit proefschrift daadwerkelijk onderzocht heeft hoe het WPL in de opleiding tot arts-specialist geoptimaliseerd kan worden, waarbij

zowel ondersteuning wordt geboden aan de ASO's alsook aan hun supervisoren. De aanbevelingen die geformuleerd werden zijn hierbij zeker een stap in de goede richting, maar verder onderzoek dient deze nog verder te ondersteunen. Daarnaast is er nog voldoende werk voor zowel de ASO's, supervisoren, onderwijskundigen, ziekenhuismanagers, onderzoekers als politici om de implementatie van de theorie in medisch onderwijskundig onderzoek naar de praktijk mee te ondersteunen. Enkel door een samenwerking tussen alle partijen zal een optimale opleiding tot arts-specialist bereikt kunnen worden.

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Curriculum Vitae

1. Personal information

Name Marieke Robbrecht

Date of birth 02/05/1993

Contact marieke.robbrecht@ugent.be

2. Education and professional experiences

2018-2026* **University of Antwerp**

Master of Medicine in Specialistic Medicine: Paediatrics

2020-2024* **Ghent University, University of Antwerp**

Doctor of Health Sciences and of Educational Sciences and Doctor of Medical Sciences

2021-2023 **University of Antwerp**

Educational Master in Health Sciences

Master thesis: Quality assurance in higher education. A case study into the perception and experience of lecturers

2017-2018 **University of Antwerp**

Master of Medicine in General Medicine *(first year completed)*

2013-2017 **University of Antwerp**

Master of Medicine

Master thesis: Changes in Perfusion Index and Temperature Characteristics for Early Bedside Clinical Diagnosis of Nosocomial Sepsis in Very Low Birth Weight Infants.

2011-2013 **University of Antwerp**

Bachelor of Medicine

2010-2011 **University of Antwerp**

Bachelor of Biomedical Sciences *(first year completed)*

2004-2010 **Sint-Jorisinstituut Bazel**

Secondary education, option Sciences-Mathematics

**Ongoing*

3. Additional trainings doctoral schools

2023	Creative thinking	Ghent University
2022	Questionnaire construction and analysis	Ghent University
2022	Method in research design	Ghent University
2022	What to know, see and do about burn out	Ghent University
2021	Creating effective research posters	Ghent University
2020	Advanced Academic English: Conference Skills - English Proficiency for Presentations	Ghent University
2020	Personal effectiveness	Ghent University

4. Memberships

2023-…	Interuniversity workgroup 'Feedback' *Chair*	VASO
2021-…	Resident workgroup 'MSG' *Chair*, *effective member*	VASO
2021-…	Student delegation Antwerp residents *Secretary, effective member*	University of Antwerp

5. PEER REVIEWED PUBLICATIONS

Robbrecht, M., Norga, K., Van Winckel, M., Valcke, M., & Embo, M. (2022). Development of an integrated competency framework for postgraduate paediatric training : a Delphi study. *EUROPEAN JOURNAL OF PEDIATRICS*, *181*, 637–646. https://doi.org/10.1007/s00431-021-04237-2

Robbrecht, M., Van Winckel, M., Norga, K., & Embo, M. (2023). Exploring residents and supervisors' workplace learning needs during postgraduate medical education. *INTERNATIONAL JOURNAL OF MEDICAL EDUCATION*, 14, 65–74. https://doi.org/10.5116/ijme.625f.bfb1

De Ruyck, O., Embo, M., Morton, J., Andreou, V., Van Ostaeyen, S., Janssens, O., **Robbrecht M.**, Saldien J., De Marez, L. (2024). A comparison of three feedback formats in an ePortfolio

to support workplace learning in healthcare education : a mixed method study. *EDUCATION AND INFORMATION TECHNOLOGIES*. https://doi.org/10.1007/s10639-023-12062-3

Janssens, O., Andreou, V., Embo, M., Valcke, M., **Robbrecht, M.**, De Ruyck, O., & Haerens, L. (2024). The identification of requirements for competency development during workintegrated learning in healthcare education. *BMC Medical Education*, *24*, 1–18. https://doi.org/10.1186/s12909-024-05428-9

6. MANUSCRIPTS SUBMITTED FOR PUBLICATION

Robbrecht, M., Van Winckel, M., Mulder, A., & Embo, M. (Under review). What is the learning effect of video review in postgraduate medical education: A systematic review.

Robbrecht, M., Van Winckel, M., Mulder, A., & Embo, M. (Under review). Paediatric Residents 'in the Picture': Stimulating Video-Assisted Self-Reflection During Workplace Learning – A Pilot Study

7. CONFERENCE PROCEEDINGS

Embo, M., De Ruyck, O., Morton, J., Van Ostaeyen, S., Wasiak, C., **Robbrecht, M**., Andreou, V., Janssens, O., Demey, H., & Valcke, M. (2023). Designing ePortfolios to improve midwifery education in practice: what's the best feedback format*?* Presented at the International Confederation of Midwives, Bali.

Andreou, V., Demey, H., De Ruyck, O., Embo, M., Janssens, O., **Robbrecht, M**., … Wasiak, C. (2023). Het SCAFFOLD ePortfolio: een inkijk in de resultaten van een multidisciplinair onderzoeksproject in Vlaanderen (2020-2023). Presented at the NVMO Congres, Maastricht.

Robbrecht, M., Embo, M., Norga, K., & Van Winckel, M. (2022). When learning takes place outside of the classroom: usage of video recording during workplace learning. Presented at the 2022 AERA ANNUAL MEETING, San Diego, USA.

All, A., Van Ostaeyen, S., Embo, M., Janssens, O., & **Robbrecht, M.** (2022). Training to support ePortfolio users: an overview of training initiatives and their outcomes. EPortfolios, an Innovative Future Ahead: Optimizing Workplace Learning in Healthcare Education, Abstracts. Presented at the 2022 AERA ANNUAL MEETING, San Diego, USA.

Robbrecht, M., Zaghi, M., Mulder, T., Norga, K., Van Winckel, M., & Embo, M. (2022). Students in the picture: how to improve workplace “learning” through the use of video recordings. INTED2022 Proceedings, 1699–1699. https://doi.org/10.21125/inted.2022.0510

Van Ostaeyen, S., All, A., **Robbrecht, M**., Andreou, V., Embo, M., Schellens, T., & Valcke, M. (2022). Online asynchronous focus groups: insights on participants’ opinions. JURE 2022: Unpredictable Challenges: Education in a Rapidly Changing World, Abstracts. Presented at the JURE 2022: Unpredictable Challenges: Education in a Rapidly Changing World, Porto, Portugal.

Robbrecht, M., Embo, M., Norga, K., Andreou, V., Janssens, O., Van Ostaeyen, S., & Van Winckel, M. (2021). Validation of a competency framework for paediatric post-graduate education: A Delphi study. *EAP2021 Congress and MasterCourse*. Presented at the EAP 2021 CONGRESS AND MASTERCOURSE, Virtual. https://doi.org/10.3389/978-2-88966-546-4

Robbrecht, M., Embo, M., All, A., Van Ostaeyen, S., & Van Winckel, M. (2021). Workplacebased learning and ePortfolio use in post-graduate medical education in Flanders (Belgium): What are the perceived needs? *EAP2021 Congress and MasterCourse*. Presented at the EAP 2021 CONGRESS AND MASTERCOURSE, Virtual. https://doi.org/10.3389/978-2-88966-546-4

Robbrecht, M., Embo, M., & Van Winckel, M. (2021). Validating a competency framework for paediatric post-graduate education. *INTED2021 Proceedings*, 6066–6066. https://doi.org/10.21125/inted.2021.1214

Robbrecht, M., Embo, M., & Van Winckel, M. (2021). Workplace-based learning and eportfolio use in post-graduate medical education in Flanders (Belgium): what are the perceived needs? *INTED2021 Proceedings*, 7606–7606. https://doi.org/10.21125/inted.2021.1531

8. OTHER

Co-supervisor of master thesis of Master of Specialistic Medicine of Ellen Allaert in period 2021-2022.

Dankwoord

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