Research Article

Entrustable Professional Activities in Medical Students

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Abstract

Objectives: The information available on the role of Entrustable Professional Activities (EPAs) in Undergraduate Medical Education (UME) remains unmeasured. This systematic review was conducted to summarize and synthesize the direction of these EPAs in UME, to identify the gaps in medical literature, and to give suggestions for further work on the matter.

Methodology: A search was conducted within 2 databases (PubMed and Google Scholar) and articles containing original work, both qualitative and quantitative, were searched for content about the development, implementation, and assessment of EPAs in UME

Results: Of the 324 articles from initial searches, 37 were finalized to be reported in this review. Of these, 11 reported on EPA development, 21 reported on EPA implementation in curricula, and 18 discussed the assessment of EPAs. Most of these reports were published in the US (70%, n=26). The most frequent articles were cohort studies, cross-sectional studies, and program evaluation studies (n=5 each). Core EPAs 1 (n=13), 2, and 6 (n=12 each) were the most frequently discussed EPAs. Developmental strategies varied vastly, with the most frequent one involving drawing out core EPAs and identifying core EPA domains to derive specialty-specific EPAs (n=2). EPA implementation greatly involved the modification of pre-existing curricula (n=7). The most frequent method of EPA implementation involved their use in simulation-based studies (n=4). In the EPA assessment, Ottawa and Chen's scales were used as frequently as point-based systems (n=4 each). Only a single study was categorically found to comment on the feasibility of these scales. Studies focussed on new program suggestions for EPA assessment (n=7) as well as the introduction of entrustment rating scales (n=4).

Conclusion: Positively significant results indicate that EPAs can serve as a very useful tool for the betterment of UME, with the various methods of development, implementation, and assessment proving helpful. However, the great disparity in study designs, the lack of standardized results, the lack of controlled trials, the prevalence of country-specific research articles, and still a lack of work focussed on EPAs at the undergraduate level are a few named factors that put a question mark on the validity of this evidence and, therefore, demand that more research be conducted in various institutes and locations.

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INTRODUCTION:

Entrustable Professional Activities (EPAs) are discrete units of practice, defined as tasks or responsibilities to be entrusted to a trainee once sufficient specific competence is reached to allow for unsupervised practice (1). These are used as a gauge in determining the level of expertise as well as a means to improve the standards of learning. Various medical specialties and subspecialties in the first world countries have developed EPAs for assessing the competency of their resident practitioners (2), however, a comprehensive, appraisal for EPAs in medical students has not yet been done. Our study, through examining existing evidence, will help identify the status and potential obstacles to integrating EPAs in undergraduate medical education (UME).

Over recent years, many professional medical supervisors and mentors worldwide have experienced a comparatively increasing lack of clinical competence in medical graduates (3). To tackle this disparity between the clinical expectations of medical graduates and the actual level of expertise they possess after graduating, detailed criteria were drafted in 2013 by the Association of American Medical Colleges (AAMC) enumerating Entrustable Professional Activities (EPAs) (4). These criteria have subsequently been reinforced and have given rise to the concept of Competency-Based Medical Education (CBME) and Outcome-Based Education (OBE) against the traditional Time-Based Medical Education (TBME) in the achievement of these core EPAs and this new scheme of education is now being preferred over the latter (5).

Recently residency training programs in many countries have successfully been incorporating the EPAs in graduate medical education (GME) (2). Now the focus of research has shifted to perfecting EPAs as frameworks for UME (6–8). Primary evaluations have found varying alignments of the core EPAs with already existing performance schemas for medical students (9). Researchers have begun to delve deeper into the case to formulate implementation programs (10), develop assessment methodologies (11), and examine the efficacy of EPAs in undergraduate medical students (12). Exploratory pilot educational programs for different academic years as well as specialty clerkships have shown promising results (13).

However, most of the studies have been conducted on medical graduates and professionals. Not many studies have been undertaken on undergraduate medical students and more work is being done in the form of clinical studies and scoping reviews (14).

Our study aims to summarize and contrast data regarding the merits and demerits of using EPAs among medical students in their clinical clerkships and the strategies to develop and implement EPAs in medical education programs, to identify gaps in current research about EPAs in UME, and to suggest further directions of research on the matter. This will assist in establishing the effectiveness of EPAs in undergraduate medical education, the likely limitations, and due solutions. This will aid

medical education directors to improve their curricula and will pave the way for future trials and analyses on the subject.

ETHODS & METHOD:

STUDY DESIGN:

A Systematic review was conducted. Systematic reviews are articles that integrate information from various research articles about a particular subject to synthesize data and assert the significance of results and are a great means to stay updated with recent developments as well as use them as guidelines in medical practice. The review was conducted by the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidelines.

SEARCH STRATEGY:

Two databases (PubMed and Google scholar) were used for conducting this review. Searches were conducted in August 2022. The search strategy used was Entrustable professional activity* AND ((student*, medical) OR (undergrad*)) and all other relevant terms. The time duration for included studies was set for the last 10 years from 2012 till January 2022. For the search stream on Google Scholar, the results on the first 10 pages were selected for screening.

STUDY SELECTION:-

Inclusion Criteria:

In our review, the articles to be included were to be original research articles only (Case series, Cohort studies, Qualitative studies, Randomized Control Trials). An English language requirement was set for the articles to be included i.e. only those articles will be included which have been written or, otherwise, translated into English. The main focus of the articles to be included was set to be on the development of EPAs, implementation of EPAs in curricula, and assessment of those EPAs in undergraduate medical students.

Exclusion Criteria:

The papers were excluded if they were unoriginal studies like commentaries, reviews and editorials based on original papers. Papers that focussed solely on the development of EPAs were also excluded from our review. Papers whose target population was directly not concerned with UME were excluded from the review. Studies that focussed on milestones other than those mentioned in the inclusion criteria were also excluded. Studies on EPAs in other professions, or at the level of GME were excluded from our review.

SCREENING PROCESS

The initial database search results were 324 articles. After removing the duplicates, two researchers did the screening process. First, the researchers screened titles and abstracts, and exclusion was made according to the criteria mentioned above. The full text was reviewed for the remaining articles and the discrepancies were solved by a third researcher. After the full-text screening, 37 articles were seen to meet the inclusion criteria and were used for data extraction.

DATA EXTRACTION:

The items of data that were extracted included the year of study, the country where the study was conducted, study design, the target year of UME,

population size, the main area of focus in the respective study i.e. development, implementation, assessment, or the feasibility of EPAs, core EPAs discussed and any specialties involved.

RESULTS

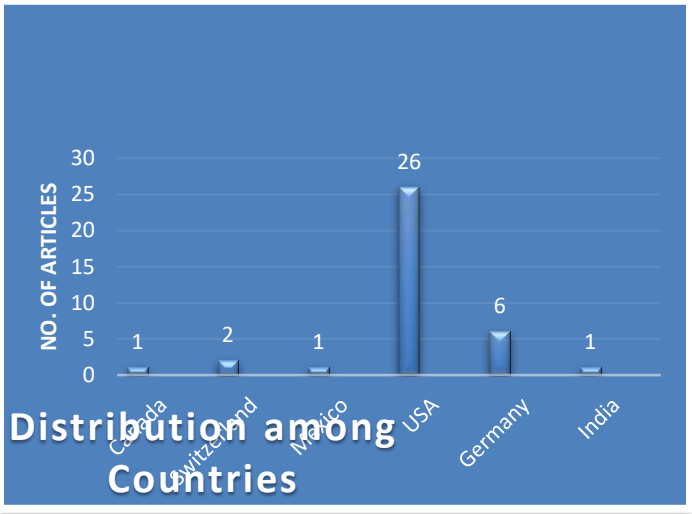
A total of 324 obtained after the removal of duplicates were screened. The process ended with 37 final included papers. Of these 37 final papers, categories of Development, Implementation and Assessment were created. With a few overlaps, a total of 11 articles fell under the Development category, 21 under the Implementation category and 18 discussed the Assessment of EPAs as their main focus.

STUDY CHARACTERISTICS:-

The studies were categorized based on Authors, Years of Publication and Country where they were published, Study designs and the main focus of the papers whether it was focused solely on the development, implementation, assessment and feasibility of EPAs. Details are provided in Table 1.

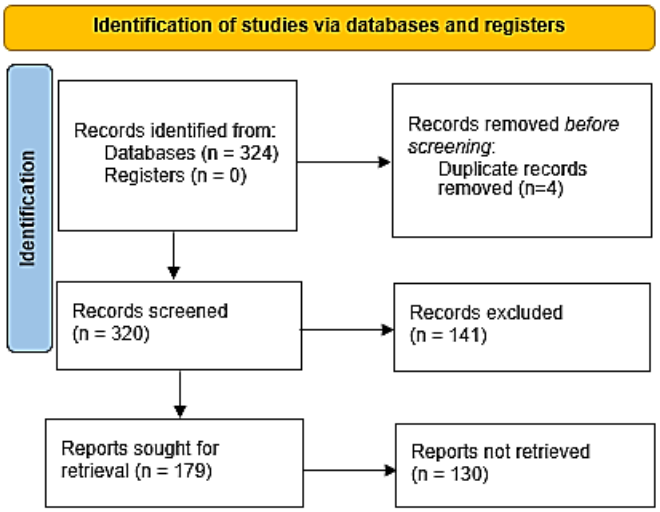
Analysis revealed that 70% of the papers (n=26) were published in the USA while 15% (n=6) were in Germany. Few studies published in Switzerland (n=2), Canada (n=1) Mexico (n=1) and India (n=1) were also among the included articles.

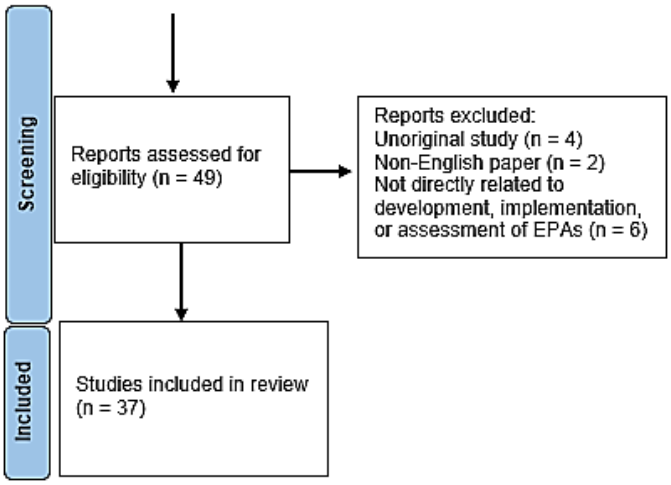
The included papers most frequently mainly focussed on the implementation of EPAs (n=10) followed by the assessment of EPAs (n=12). Few papers discussed solely EPA development (n=2), and few still focussed on the both development and implementation of EPAs (n=3) as well as on both implementation and assessment (n=5). There was



one paper each focussed on the feasibility of EPAs (15) as well as 2 that focussed on all 3 aspects of development, implementation and assessment of EPAs (n=2).

The most frequent study designs were longitudinal studies (n=6), cohorts (n=5), cross-sectional studies (n=5) and program evaluations (n=5). These were followed in number by pilot studies (n=3), expert consensuses (n=3), educational case reports (n=3) and Mixed-method studies (n=2). There was only 1 article each for case-control studies, case-simulation studies, randomized control trials, Educational models and Experimental studies.





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

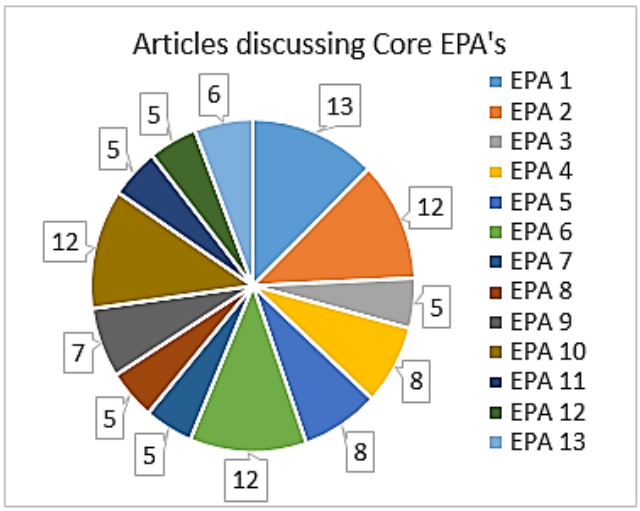
Among the other characteristics for which the articles were studied, a detailed analysis is hereby given in Table 2.

The most frequent study population was of 4th-year medical students (n=7) followed by final-year medical students (n=5). Studies also involved 3rd-year medical students (n=4) as well as students in their 1st and 2nd years in the undergraduate medical curriculum. For the rest of the papers, the target years were either not mentioned clearly, or they were too mixed and spread across various levels in UME. Still, a few expert consensuses had an altogether different population comprising medical experts and curriculum developers.

The clerkship specialty most frequently involved was of internal medicine (n=6) followed by emergency medicine (n=5). Along with these, articles were also written based on setups in surgery (n=3), pediatrics (n=3) and psychiatry (n=3) clerkships.

The most frequently discussed EPA out of all the core EPAs was EPA 1 (history taking) which was discussed in a total of 13 papers, followed by EPA 2 (carrying out a physical exam) and EPA 6 (presentation of patient history) which were each discussed in 12 papers. EPAs 3, 7, 8 11 and 12 were the least implemented or assessed EPAs and were discussed in a total of 5 articles each. Details entailed in the Pie chart are as follows.

Pie Chart: Number of articles addressing specific EPAs



Categorized results and findings are discussed below:-

Development:-

In our review, we found that 19% (n=7) and 11% (n=4) articles focused on the development of specialty-specific EPAs (10,16–21) and the development of EPA-based curricula (22–25) respectively.

Among the specialty-specific EPAs, the clerkships involved were Emergency Medicine (16), Internal

Medicine (10), Obs. and Gynae. (17,24), Surgery (10,20) and General Medicine(10).

A very contrasting array of EPA development methods was seen in the included papers. Lamba et al (16) mapped out core EPAs as well as EPA milestones and then derived specific EPAs for Emergency Medicine in Final Year medical students. Chen et al (19) used a similar approach, with a focus on describing the domains of the EPAs mapped out. In the study by Mihaljevic et al (20), 3 EPAs were defined after drawing out objectives for an Inter-professional Training Ward (IPTW) curriculum. Pinilla et al (21) developed a curriculum based on the perceived gaps between medical graduates and interns. Fazio et al (17) mention the process whereby a task force consisting of experts on UME, GME as well as Fellowship Educators carried out an extensive literature search and review to develop EPAs for Internal Medicine. In the study carried out by Berberat et al (10), experts from a Sub-Working Group (SWG) of the Medical Faculty Association (MFT) in Germany drafted a model EPA and then derived a discipline-specific EPA blueprint in a circulatory process for Surgery and Internal Medicine as well as for the elective rotation of General Medicine. Brätz et al (18) developed an altogether different line of 12 prospective EPAs based on different competency domains.

Of the studies mentioning not the development of EPAs but of curricula, an even vast range of findings was seen. Liao et al (22) constructed a workshop-based strategy for teaching EPA 4. In the study by Torruco-García (24), a multi-disciplinary group of experts joined together to form a model based on generic EPAs along with developing EPAs specific for Ob/Gyn rotations. A German study (20) used a specific approach to Interprofessional learning by incorporating psychological, educational and sociological inter-professional theories to incorporate EPAs in Interprofessional training wards (IIPTWs. Mejicano et al (25) adopted a similar course introducing EPA-based curriculum reforms by mapping out the six core domains of competency in UME and then integrating the course around them.

Implementation:-

Of all 37 samples, 57% (n=21) discussed the implementation of EPAs in UME. Of those, 33% (n=7) involved modified curricula based on EPAs simply by inculcating them in already existing models (16,21,23,24,26–29).

Various approaches were used in the implementation of EPA-based frameworks. Many of the strategies were institute-specific (16,30–32). The most frequent method of implementation involved simulation-based training (22,33–35). EPAs were inculcated as part of Emergency Medicine boot camps (16). Workshops were introduced for EPA learning (22). There was a specific study in which worksheets were used as means to achieve entrustment levels for EPA 7 by O'Neil et al (31). Inter-professional training wards (IPTW's) were established in two separate studies (20,36). Manning et al (36) stated the effectiveness of an evidence-based learning model promoting

students to achieve entrustment through quality improvement (QI) processes. There was one study in India that involved a portfolio-based EPA framework (32). There was a single study that involved individualized coaching for students by assigned mentors (25). Salzman et al (13) proposed a mastery learning strategy for EPAs involving various educational activities and practices. Bosinski et al (26) followed a similar approach. Many of the studies simply involved the addition of EPAs in pre-existing curricular setups (16,21,23,24,26–29).

Of the 21 implemented samples, 24% (n=5) utilized sub-internship and clerkship rotations (21,26,27,37). 24% (n=5) (16,37) additionally discussed Assessment as a focus of these studies.

86% (n=18) of these identified studies showed positive outcomes (13,16,18,20–28,30,31,33–36), with 73% (n=16) being statistically significant while the rest (n=2) did not involve statistics (20,27) and claimed that the models implemented were practically efficient without major statistics involved. The remaining one article did not depict any significant results (32) for their proposed models.

Assessment:-

Eighteen studies addressed the assessment of the core EPAs, four of which were focused specifically on the EPA 10 (33,38–40), while one study developed an assessment model for their own set of newly developed EPAs. (18)The most used tools for assessment were found to be the Ottawa and Chen scales, and point-based rating systems.

Four studies were based on the introduction of entrustment rating scales (10,21,28,37,41); out of these one reported lower entrustment levels on the new entrustment scale (37), while another (21) noted higher competency levels; one study remarked upon the feasibility (37). One study presented the Minnesota method for assessment. (42) In one study, the feasibility of the modified Ottawa scale was assessed (43). In addition, Ottawa Surgical Competency Operating Room Evaluation (O-SCORE) Scale has been generalized for usage regarding all core EPAs.(44)

Seven studies focus on the programs which have been suggested for assessment. These include mobile technology for workplace-based assessments (45), case simulations based on specific clinical scenarios to assess students' response to the situation (33,39,40), videotaping the students' practical exam and rating by assessors after watching the recording (26), and physician mentored patient rounds (PMPR) All of these have been stated to be effective methodologies. One study established observable student behaviors for assessment of EPA 10. 8 student behaviors were reported to be highly predictive of competence. (38)

A validation study has been carried out for the Ottawa and Chen scales.

Chart 1: Scales used in included studies.

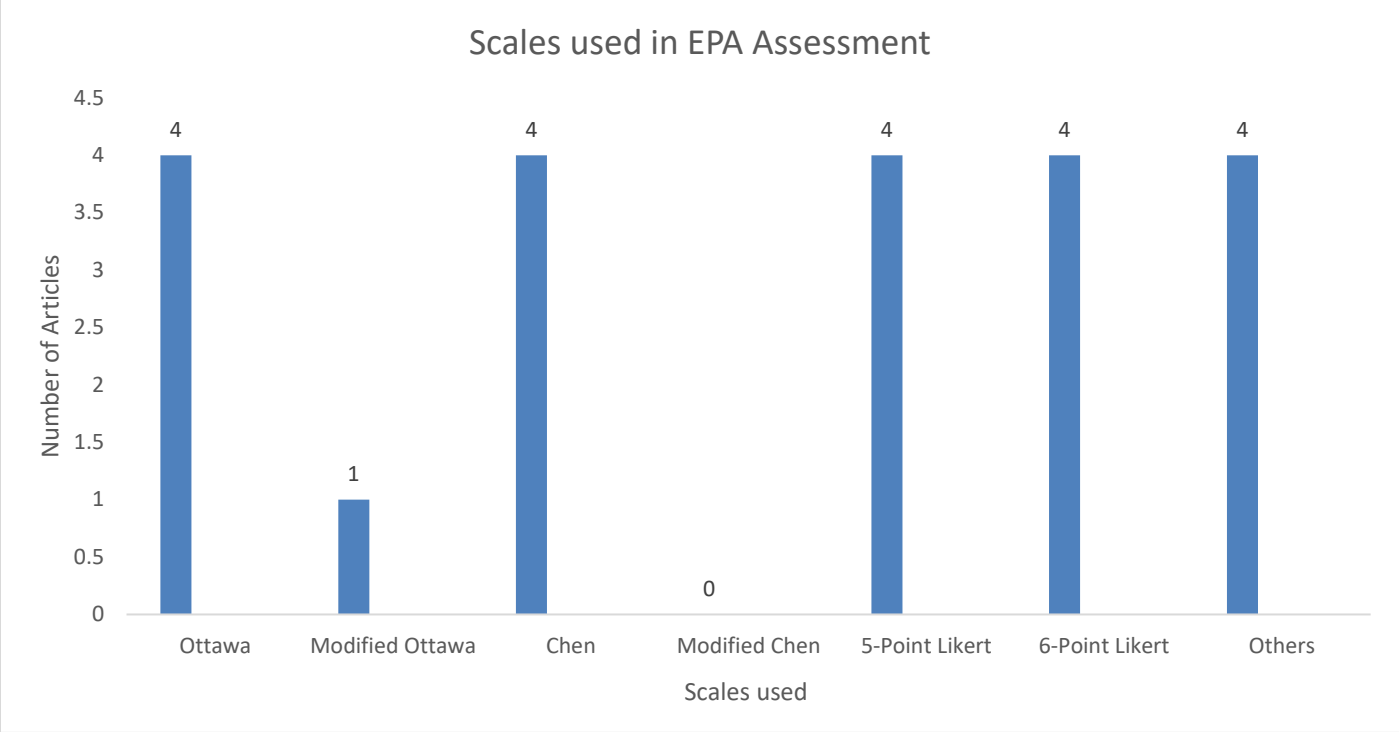


Table 1:-

	Authors & Reference Nos.	Year	Title	Country	Study Design	Main Focus
1	Lomis et al (30)	2017	Implementing an Entrustable Professional Activities Framework in Undergraduate Medical Education: Early Lessons From the AAMC Core Entrustable Professional Activities for Entering Residency Pilot	USA	Pilot Study	Implementation
2	Liao et al (22)	2022	Enter and Discuss Orders and Prescriptions (EPA 4): A Curriculum for Fourth-Year Medical Students	USA	Cohort	Development, Implementation
3	Lamba et al (16)	2016	A suggested emergency medicine boot camp curriculum for medical students based on the mapping of Core Entrustable Professional Activities to Emergency Medicine Level 1 milestone	USA	Pilot EM boot camp	Development, Implementation
4	Kman et al (33)	2016	Entrustable Professional Activity 10: Case Simulation and	USA	Case simulation and assessment	Implementation, Assessment

			Assessment-STEMI With Cardiac Arrest			
5	Holzhausen et al (37)	2019	Exploring the introduction of entrustment rating scales in an existing objective structured clinical examination	Germany	Longitudinal Study	Implementation, Assessment
6	O'Neil et al (31)	2018	Critical Appraisal Worksheets for Integration Into an Existing Small-Group Problem-Based Learning Curriculum	USA	Program Evaluations	Implementation
7	Zackoff et al (38)	2020	Establishing Objective Measures of Clinical Competence in Undergraduate Medical Education Through Immersive Virtual Reality	USA	Cross-Sectional Study	Assessment
8	Thompson et al (39)	2017	Development of an Assessment for Entrustable Professional Activity (EPA) 10: Emergent Patient Management	USA	Cross-Sectional Study	Assessment
9	Imm et al (43)	2021	Applying Coactivity Scales to Entrustable Professional Activity Assessments of Clerkship Students	USA	Cohort	Assessment
10	Schick et al (29)	2019	Implementing a logbook on entrustable professional activities in the final year of undergraduate medical education in Germany - a multicentric pilot study	Germany	Cross-Sectional Study	Implementation
11	Ryan et al (44)	2021	Generalizability of the Ottawa Surgical Competency Operating Room Evaluation (O-SCORE) Scale to Assess Medical Student Performance on Core EPAs in the Workplace: Findings From One Institution	USA	Cohort	Assessment
12	Herrigel et al	2020	Simulation as a Platform for Development of Entrustable Professional Activities: A Modular, Longitudinal Approach	USA	Longitudinal study	Assessment
13	Fazio et al (17)	2018	Competency-Based Medical Education in the Internal Medicine Clerkship: A Report From the Alliance for Academic Internal Medicine Undergraduate Medical Education Task Force	USA	Expert Consensus	Development
14	Datta et al	2021	Development of a portfolio	India	Expert	Implementation

	(32)		framework for implementation of an outcomes-based healthcare professional education curriculum using a modified e-Delphi method		Consensus	
15	Manning et al (36)	2018	Using Medical Student Quality Improvement Projects to Promote Evidence-Based Care in the Emergency Department	USA	Program Evaluations	Implementation
16	Garber et al (23)	2021	Core EPAs in the Acting Internship: Early Outcomes from an Interdepartmental Experience	USA	Longitudinal Single Cohort Study	Implementation
17	Dora-Laskey et al (40)	2016	Entrustable Professional Activity 10: Recognizing the Acutely Ill Patient-A Delirium Simulated Case for Students in Emergency Medicine	USA	Educational Case Reports	Assessment
18	Duggan et al (45)	2021	Using mobile technology in the assessment of entrustable professional activities in undergraduate medical education	Canada	Cross-Sectional Study	Assessment
19	Dunne et al	2022	WBAs in UME-How Many Are Needed? A Reliability Analysis of 5 AAMC Core EPAs Implemented in the Internal Medicine Clerkship	USA	Longitudinal Single Cohort Study	Assessment
20	Brätz et al (18)	2022	Assessment of final-year medical students' entrustable professional activities after education on an interprofessional training ward: A case-control study	Germany	Case-Control Study	Development, Implementation, Assessment
21	Torruco-García et al (24)	2016	[Competence development in undergraduate medical schools: a model with entrusted professional activities]	Mexico	Educational Model	Development, Implementation
22	Salzman D et al (13)	2019	A Mastery Learning Capstone Course to Teach and Assess Components of Three Entrustable Professional Activities to Graduating Medical Students	USA	Educational Case Reports	Implementation
23	Ryan et al	2022	Workplace-Based Entrustment Scales for the Core EPAs: A Multisite Comparison of Validity Evidence for Two Proposed Instruments Using Structured Vignettes and Trained Raters	USA	RCT	Assessment
24	Bosinski et al	2022	Using the EPAs to Evaluate the	USA	Cross-Sectional	Implementation,

	(26)		Clinical Experience of Medical Students		Study	Assessment
25	Pinilla et al (21)	2021	Introducing a Psychiatry Clerkship Curriculum Based on Entrustable Professional Activities: an Explorative Pilot Study	Switzerland	Program Evaluations	Development, Implementation, Assessment
26	Peters et al (41)	2019	Introducing an assessment tool based on a full set of end-of-training EPAs to capture the workplace performance of final-year medical students	Germany	Program Evaluations	Assessment
27	Chen et al (19)	2016	Developing Entrustable Professional Activities for Entry Into Clerkship	USA	Program Evaluations	Development
28	Chamberlain et al	2018	Physician-Mentored Patient Rounds to Observe and Assess Entrustable Professional Activities 1 and 2 in Preclinical Medical Students	USA	Cohort	Assessment
29	Costich et al (34)	2021	Transition-to-residency: pilot innovative, online case-based curriculum for medical students preparing for pediatric internships	USA	Educational Case Reports	Implementation
30	Mihaljevic et al (20)	2018	Heidelberger Interprofessionelle Ausbildungsstation (HIPSTA): a practice- and theory-guided approach to development and implementation of Germany's first interprofessional training ward	Germany	Experimental study	Development, Implementation
31	Pinilla et al (28)	2021	Workplace-based assessments of entrustable professional activities in a psychiatry core clerkship: an observational study	Switzerland	Longitudinal Single Cohort Study	Implementation, Assessment
32	Mejicano et al (25)	2018	Describing the Journey and Lessons Learned Implementing a Competency-Based, Time-Variable Undergraduate Medical Education Curriculum	USA	Cohort	Development, Implementation
33	Austin et al (35)	2020	Development and evaluation of a simulation-based transition to clerkship course	USA	Mixed-Method Study	Implementation, Assessment
34	Beekman et al (27)	2019	Patient Safety Morning Report: Innovation in Teaching Core Patient Safety Principles to Third-Year Medical Students	USA	Longitudinal study	Implementation
35	Brown et al	2017	Finding a Path to Entrustment in	USA	Pilot study	Implementation,

	(15)		Undergraduate Medical Education: A Progress Report From the AAMC Core Entrustable Professional Activities for Entering Residency Entrustment Concept Group			Feasibility
36	Berberat et al (10)	2019	Entrustable Professional Activities in final year undergraduate medical training - advancement of the final year training logbook in Germany	Germany	Expert Consensus	Development, Assessment
37	Hobday et al (42)	2021	The Minnesota Method: A Learner-Driven, Entrustable Professional Activity-Based Comprehensive Program of Assessment for Medical Students	USA	Pilot Mixed-Method Study	Assessment

Core EPAs 1 (history taking), 2 (physical examination of a patient) and 6 (presenting a patient's history) were the most frequently implemented and assessed core EPAs among the 13 core EPAs proposed by AAMC. These specific EPAs are most commonly taught in clinical rotations undergone by medical undergraduates and therefore may arguably be deemed the most basic of the core EPAs. The least frequently assessed EPAs 3 (recommend diagnostics), 7 (retrieve information and evidence), 8 (patient handover), 11 (obtaining informed consent), and 12 (obtaining general procedures) might be so labeled because these are more related to actual, practical patient care.

Table 2:-

Sr. No.	Authors	Target Year of UME	Specialty (if any)	Core EPAs	Summary of Main Results
1	Lomis et al.	-	-	1-13	Implementation of the Core EPA framework will enhance the transition from undergraduate to graduate medical education with the ultimate goal of improving patient care.
2	Liao et al	4th year	-	4	Students who participated in the EPA 4 order entry workshop showed a statistically significant increase in their confidence level.
3	Lamba et al	Final year	Emergency Medicine	10	Students participated in a 1-day, three-station advance ABCs procedure workshop. All participants reported: 1) increased knowledge and confidence in covered

					topics and 2) overall satisfaction with the simulation experience.
4	Kman et al	4th year	Emergency Medicine	10	The simulation scenario was designed to elicit EPA-10-related behaviors for learner assessment to guide Entrustment decisions. 114 out of 185 students participated in the EPA 10 assessment. Faculty raters reached a judgment of entrustment for 86 percent of students at the end of the case.
5	Holzhausen et al	Final year	Internal Medicine	10, 12	A 6-point entrustment scale was added to the standard ratings in an OSCE administered prior to students' final clerkship year in the undergraduate medical programme. Students received generally high standard OSCE ratings, whereas entrustment ratings were more widely distributed.
6	O'Neil et al.	1st year	-	7	All first-year students in the class of 2020 participated in the critical Appraisal Worksheets activity. Based on Student t-test analysis, students who completed both questionnaires showed an average improvement of 4% (p= .03). Students who scored at or below the 50th percentile on the pre-intervention questionnaire showed an average improvement of 12%(p= .002)
7	Zackoff et al.	4th year	-	10	Virtual Reality can be used to establish objective and observable performance standards for assessment of EPA attainment- a key step in moving towards competency-based medical education.
8	Thompson et al.	4th year	Emergency medicine	10	99 out of 114 students who participated in the EPA-10 assessment were rated as having reached entrustment to manage the care of an emergent patient. High-fidelity simulation showed good potential for effective assessment of medical student entrustment of caring for the emergent patient.

9	Imm et al.	-	-	-	The University of Miami EPA assessment tool provides a useful measure of student readiness for patient care.
10	Schick et al.	Final year	Surgery, Internal Medicine, and General practice	1, 2, 3, 4	Five different aspects important for implementing the EPA curriculum in undergraduate medical education in the German context were identified: The implementation process of the EPA curriculum and required resources, Entrustment process, Feedback sessions with supervisors, Students' and supervisors' role perception, Overall impact of EPAs on training conditions in the practical year.
11	Ryan et al.	-	-	1, 6	Workplace-based assessment (WBA) system was used to provide formative feedback for the Core EPAs across all clinical clerkships. The O-SCORE demonstrated modest reliability when used across clerkships. Specific challenges for implementing WBAs for the Core EPAs included the process for requesting WBAs, rater training, and application of the O-SCORE scale in medical student assessment.
12	Herrigel et al.	4th year	-	-	Early adoption of EPA-based simulation curricula in the clinical years is feasible and generalizable and lends itself to good formative assessment through catalytic learning.
13	Fazio et al.	-	Internal Medicine	1, 2, 3, 6	Six key EPAs emerged: generating a differential diagnosis, obtaining a complete and accurate history and physical exam, obtaining focused histories and clinically relevant physical exams, preparing an oral presentation, interpreting the results of basic diagnostic studies, and providing well-organized clinical documentation. A model for assessment was proposed, with descriptors aligned to the scale of supervision and mapped to the Accreditation Council

					for Graduate Medical Education domains of competence.
14	Datta et al.	-	-	-	Portfolios are one such tool that assists both in the implementation and assessment of suchcompetency-basedd curriculum. MEDEX-G consensus template is an important development to encourage the adoption of portfolios in a competency-based medical education curriculum.
15	Manning et al.	3rd year	Emergency Department	13	Using this novel technique of aligning small groups of medical students with seasoned mentors, it is feasible for medical students to learn important aspects of Quality improvement (QI) implementation and allows for their engagement to more efficiently move evidence-based medicine from the literature to the bedside.
16	Garber et al.	4th year	-	4, 6, 8, 9, 10	The majority of fourth-year medical students are capable of performing advanced Core EPAs at a level acceptable for intern year by the conclusion of their acting internship rotations. Workplace-based assessment data collected can also aid in ad hoc and longitudinal summative Core EPA entrustment decisions.
17	Dora-Laskey et al.	4th year	Emergency Medicine	10	In order to test EPA-10, high-fidelity simulation cases were designed to assess medical students rotating through EM clerkships and sub-internships on their ability to identify and stabilize patients with an acute, critical illnesses.
18	Duggan et al.	-	-	1-13	The use of mobile technology to assess entrustable professional activity achievement across a core clerkship curriculum is a feasible and acceptable modality for workplace-based assessment. Preceptors and students were satisfied with the ease of use and

					dependability of the mobile assessment platform; however, students felt the quality of formative coaching feedback could be improved.
19	Dunne et al.	-	internal medicine	1, 2, 5, 6	WBAs were used to procure Ottawa scale ratings on 5 core EPAs, to show high variance and reliability that ranged from 0.02 to 0.60
20	Brätz et al	Final year	-	-	A comparison of an ITW group and a control group was made showing increased overall mean entrustment level and interrater reliability in the ITW group
21	Torruco-García et al	-	Obstetrics and Gynecology	-	A manual was drawn up with daily clinical practice, reflection activities, assessment instruments, and a bibliography from two published models of EPAs and the curriculum of a school of medicine
22	Salzman D et al.	-	-	2, 4, 11	Medical students completed a transition to residency course and met or exceeded the Minimum Passing Standards for each of the three EPA-based clinical skills being assessed
23	Ryan et al.	-	-	NA	579 EPA assessments show rating variability on Chen and Ottawa scales attributed to the learner–EPA interaction
24	Bosinski et al.	3rd year	-	1, 5, 6	Determining the frequency of use of EPAS as follows: EPA-1 more frequently in the outpatient setting, EPA-1 and EPA-6 most often during emergency medicine, and EPA-5 during internal medicine
25	Pinilla et al.	4th year	Psychiatry	1, 2, 5, 6	A pilot study of a reformed clerkship curriculum based on EPAs showed increasing satisfaction with the clerkship and decreasing dependency on supervision
26	Peters et al.	Final year	-	-	A tool introduced using which, students' and supervisors' ratings showed an overall good internal

					consistency as well as variability between and within the EPAs
27	Chen et al.	2nd and 3rd year	-	1, 2, 9	Workshops were carried out that showed a single level of supervision was appropriate and 7-step EPA descriptions were drawn up
28	Chamberlain et al.	-	internal medicine	1, 2	PMPRs are an effective way to access students' diagnostic accuracy in EPA 1 and EPA 2
29	Costich et al.	-	Pediatrics	2, 4, 10	Increased self-reported knowledge after completion of the pilot pediatric cases within an innovative, hybrid transition-to-residency course
30	Mihaljevic et al.	-	Surgery	-	Confirmation of the feasibility of running IPTW that has its learning objectives operationalized as EPAs and shows increasing self-reported improvement
31	Pinilla et al.	4th year	Psychiatry	1-9	WBAs were used to evaluate the frequency of use of EPAs and self-entrustment levels in EPAs (highest in 1,2 and 8)
32	Mejicano et al.	-	-	1-13	The article is a description of the journey of a school dramatically transforming the UME curriculum to better prepare the physicians of the future and to do so in a manner that embraces a competency-based, time-variable framework
33	Austin et al.	-	-	5-13	Developed and implemented a simulation-based transition course that showed significant improvement and highlighted three themes, learning environment, faculty engagement, and collegiality
34	Beekman et al.	3rd year	Pediatrics	-	Identification and amelioration of Patient Safety in accordance with the SAFE framework
35	Brown et al.	-	-	-	Development of a model to reflect the entrustment procedure based on discernment, conscientiousness, and truthfulness along with knowledge
36	Berberat et al.	Final year	internal	1, 2, 5, 6	18 EPAs related to inpatient and outpatient care were

			medicine, surgery and general medicine		operationalized with short descriptions and supervision levels through an FY model logbook
37	Hobday et al.	-	Pediatrics	1-3,5-13	drawn up assessments, the progress of which could be monitored by the students and faculty and reported to the clinical competency committee to discern readiness to transition to residency

DISCUSSION:-

Entrustable professional activities have recently been gaining the spotlight with respect to UME. We conducted this systematic review with the purpose of examining available data concerning EPAs regarding their development, implementation into undergraduate training, and various modes of assessment currently being utilized. We synthesized 37 relevant research articles to present available evidence for designing curricula based on EPAs

In our review, we recognized considerable variability in the methods of development of EPAs and EPA-specific curricula, their implementation strategies, and assessment in UME. This heterogeneity was also noted by Pinilla et al (14). We further found that the most common avenue was implementation.

We found considerable focus on the development of specialty-specific EPAs for undergraduates (10,16–20). Establishing appropriate EPA-based frameworks for specialty-specific rotations was noted to be challenging and yet, it is an essential milestone in making room for EPAs in UME, since medical students must be adequately competent in all specialties at the time of graduation. While various methods have been employed to this effect, including mapping out EPA milestones from core EPAs (16,19), a literature review by an educator-based task force (17), and expert-driven drafting of model EPAs to derive specialty-specific EPAs(10), no standardized approach has been established yet. The same was found to be true about the development of EPA-specific curricula. For UME specifically, the development of further EPAs seems rather unnecessary owing to the presence of the 13 acclaimed core EPAs proposed by AAMC, and the act of EPA development at this level seems limited for the purpose of research studies only.

Regarding the implementation of EPAs, the most favored approach was seen to be the modification of already existing curricula by inculcating EPA-specific facets (16,21,23,24,26–29). Various other designs are becoming increasingly popular, such as simulation-based training (33–35), inter-professional training wards (18,20), and workshops (22). There were studies that focused on EPA implementation for specific EPAs and therefore adopted similarly specific strategies. For example, one such study involved the use of worksheets to

promote literature review and evidence-based information gathering according to core EPA 7 (31). The diversity in these implementation strategies is noteworthy. Negative results were not seen for these modes of implementation, which we think might simply be because of making the students learn their coursework and not specifically because of EPA implementation.

Assessment of undergraduate EPAs is, perhaps, the most heterogeneous in terms of methodologies. Not counting the Ottawa and Chen scales, most papers preferred constructing their own rating scales, which varied from simple Likert scales to complex supervision scales. A multitude of assessment designs are also seen, among which of note are case-simulation-based assessments (33,39,40), and mobile-based assessments seem to be gaining popularity as well (45). Additionally, only a few studies reported on the reliability of the assessment method.

A remarkable fact was that publications rarely mentioned the feasibility of EPA-specific curricula and assessment methodologies, possibly suggesting that the educators and major stakeholders are, to some extent, still skeptical about the strategies already documented, and are still largely intent on devising better programs. In contrast, most of the results have shown positive outcomes with respect to the validity of the implementation and assessment of EPA-based curricula.

The majority of our included studies were centered in two countries, namely the United States and Germany. A similar disparity was noted by Kerth et al. While this inconsistency is, quite possibly, reflective of most education-based research work being carried out in these regions, it does highlight the issue that the results of these publications should not be generalized to the worldwide community of medical education owing to differing sets of educational challenges and targets in various portions of the world.

Our study is the first systematic review regarding the inclusion of EPAs into undergraduate medical education. However, like other research of its kind, it has a few limitations. The heterogeneity of study designs of our included studies hindered carrying out a meta-analysis. Many of the studies focused on implementing EPAs in specialty-specific clerkships and we believe that implementing them in non-general rotations like Ob/Gyn (24), Pediatrics (19) and Psychiatry (21) in small numbers may lead to significant bias in the results. Owing to the language barrier, we only included articles that were published in English or had an English translation available, due to which relevant articles in other languages might have been missed. Furthermore, we were only able to search two databases, consequently, any relevant articles in the grey literature might be overlooked.

Through this review, we were able to call attention to the areas in the topic where current research is lacking. A greater number of feasibility evidence is needed for development and implementation methodologies. Also, robust reliability analyses of assessment methods are needed before they are brought into general practice. Most of the EPA-

based curricula and assessment methods are untested in larger, more diverse settings. Furthermore, as noted above, more publications from different areas of the world are needed to consider and cater to their specific requirements. Moreover, further work on specific EPAs focused on other specialties in UME is anticipated. For this purpose, assistance could be found in the form of specialty-specific EPAs for postgraduate medical education, since extensive work has been done in that domain (2). Through this systematic review, we have sought not only to clarify the current standing but also to highlight the gaps in the literature, as well as to provide possible avenues for future research. While the introduction of EPAs in undergraduate medical education is seeing remarkable advancement as of late, there are still areas of weakness and potential growth.

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REFERENCES:

1. ten Cate O, Young JQ. The patient handover as an entrustable professional activity: adding meaning in teaching and practice. BMJ Qual Saf. 2012;21(1):9-12.
2. Liu L, Jiang Z, Qi X, Xie A, Wu H, Cheng H, et al. An update on current EPAs in graduate medical education: A scoping review. Med Educ Online. 2021;26(1):1981-198.
3. Ragsdale JW, Habashy C, Warrier S. Developing Physical Exam Skills in Residency: Comparing the Perspectives of Residents and Faculty About Values, Barriers, and Teaching Methods. J Med Educ Curric Dev. 2020;7 (1):2382120520972675.
4. Englander R, Flynn T, Call S, Carraccio C, Cleary L, Fulton TB, et al. Toward Defining the Foundation of the MD Degree: Core Entrustable Professional Activities for Entering Residency. Acad Med. 2016;91(10):1352–8.
5. Tanaka A, Kondo T, Urushibara-Miyachi Y, Maruyama S, Nishigori H. Development of entrustable professional activities for residents rotating nephrology department in a Japanese university hospital: a Delphi study. BMJ Open. 2021;11(8):e047923.
6. Jafarey NA. Towards Competency Based Undergraduate Curriculum In Pakistan. 2012;2(1):1–2.
7. Nayyar B, Yasmeen R, Khan RA. Using language of entrustable professional activities to define learning objectives of radiology clerkship: A modified Delphi study. Med Teach. 2019;41(12):1419–26.
8. Younas A, Khan RA, Yasmin R. Entrustment in physician-patient communication: a modified Delphi study using the EPA approach. BMC Med Educ. 2021;21(1):497.
9. Colbert-Getz JM, Lappe K, Northrup M, Roussel D. To What Degree Are the 13 Entrustable Professional Activities Already Incorporated Into Physicians' Performance Schemas for Medical Students? Teach Learn Med. 2019;31(4):361–9.
10. Berberat PO, Rotthoff T, Baerwald C, Ehrhardt

M, Huenges B, Johannink J, et al. Entrustable Professional Activities in final year undergraduate medical training - advancement of the final year training logbook in Germany. GMS J Med Educ. 2019;36(6):70.

11. Curran VR, Deacon D, Schulz H, Stringer K, Stone CN, Duggan N, et al. Evaluation of the Characteristics of a Workplace Assessment Form to Assess Entrustable Professional Activities (EPAs) in an Undergraduate Surgery Core Clerkship. J Surg Educ. 2018;75(5):1211–22.
12. Fürstenberg S, Schick K, Deppermann J, Prediger S, Berberat PO, Kadmon M, et al. Competencies for first year residents - physicians' views from medical schools with different undergraduate curricula. BMC Med Educ. 2017;17(1):154.
13. Salzman DH, McGaghie WC, Caprio TW, Hufmeyer KK, Issa N, Cohen ER, et al. A Mastery Learning Capstone Course to Teach and Assess Components of Three Entrustable Professional Activities to Graduating Medical tudents. Teach Learn Med. 2019;31(2):186–94.
14. Pinilla S, Lenouvel E, Cantisani A, Klöppel S, Strik W, Huwendiek S, et al. Working with entrustable professional activities in clinical education in undergraduate medical education: a scoping review. BMC Med Educ. 2021; 21(1):172.
15. Brown DR, Warren JB, Hyderi A, Drusin RE, Moeller J, Rosenfeld M, et al. Finding a Path to Entrustment in Undergraduate Medical Education: A Progress Report From the AAMC Core Entrustable Professional Activities for Entering Residency Entrustment Concept Group. Acad Med. 2017;92(6):774–9.
16. Lamba S, Wilson B, Natal B, Nagurka R, Anana M, Sule H. A suggested emergency medicine boot camp curriculum for medical students based on the mapping of Core Entrustable Professional Activities to Emergency Medicine Level 1 milestones. Adv Med Educ Pract. 2016;7(1):115–24.
17. Fazio SB, Ledford CH, Aronowitz PB, Chheda SG, Choe JH, Call SA, et al. Competency-Based Medical Education in the Internal Medicine Clerkship: A Report From the Alliance for Academic Internal Medicine Undergraduate Medical Education Task Force. Acad Med. 2018;93(3):421–7.
18. Brätz J, Bußenius L, Brätz I, Grahn H, Prediger S, Harendza S. Assessment of final-year medical students' entrustable professional activities after education on an interprofessional training ward: A case-control study. Perspect Med Educ. 2022;11(5):266-72.
19. Chen HC, McNamara M, Teherani A, Cate O Ten, O'Sullivan P. Developing Entrustable Professional Activities for Entry Into Clerkship. Acad Med. 2016;91(2):247–55.
20. Mihaljevic AL, Schmidt J, Mitzkat A, Probst P, Kenngott T, Mink J, et al. Heidelberger Interprofessionelle Ausbildungsstation (HIP-STA): a practice- and theory-guided approach to development and implementation of Germany's

first interprofessional training ward. GMS J Med Educ. 2018;35(3):33.

21. Pinilla S, Cantisani A, Klöppel S, Strik W, Nissen C, Huwendiek S. Introducing a Psychiatry Clerkship Curriculum Based on Entrustable Professional Activities: an Explorative Pilot Study. Acad psychiatry J Am Assoc Dir Psychiatr Resid Train Assoc Acad Psychiatry. 2021;45(3):354–9.
22. Liao N, Leung C, Barbee J, Gonzales G, Schaffernocker T, Kman N, et al. Enter and Discuss Orders and Prescriptions (EPA 4): A Curriculum for Fourth-Year Medical Students. MedEd PORTAL J Teach Learn Resour. 2022;18(3):11263.
23. Garber AM, Feldman M, Ryan M, Santen SA, Dow A, Goldberg SR. Core EPAs in the Acting Internship: Early Outcomes from an Interdepartmental Experience. Med Sci Educ. 2021;31(2):527–33.
24. Torruco-García U, Ortiz-Montalvo A, Varela-Ruiz ME, Hamui-Sutton A. Competence development in undergraduate medical schools: a model with entrusted professional activities. Gac Med Mex. 2016;152(2):173–90.
25. Mejicano GC, Bumsted TN. Describing the Journey and Lessons Learned Implementing a Competency-Based, Time-Variable Under graduate Medical Education Curriculum. Acad Med. 2018;93(3S):42–8.
26. Bosinski C, Rice M, Mason M, Germain LJ. Using the EPAs to Evaluate the Clinical Experience of Medical Students. Prim (Leawood, Kan). 2022;6(1):13.
27. Beekman M, Emani VK, Wolford R, Hanson K, Wickham G, Aiyer M. Patient Safety Morning Report: Innovation in Teaching Core Patient Safety Principles to Third-Year Medical Students. J Med Educ Curric Dev. 2019;6(1):2382120519842539.
28. Pinilla S, Kyrou A, Klöppel S, Strik W, Nissen C, Huwendiek S. Workplace-based assessments of entrustable professional activities in a psychiatry core clerkship: an observational study. BMC Med Educ. 2021;21(1):223.
29. Schick K, Eissner A, Wijnen-Meijer M, Johannink J, Huenges B, Ehrhardt M, et al. Implementing a logbook on entrustable professional activities in the final year of undergraduate medical education in Germany - a multicentric pilot study. GMS J Med Educ. 2019;36(6):69.
30. Lomis K, Amiel JM, Ryan MS, Esposito K, Green M, Stagnaro-Green A, et al. Implementing an Entrustable Professional Activities Framework in Undergraduate Medical Education: Early Lessons From the AAMC Core Entrustable Professional Activities for Entering Residency Pilot. Acad Med. 2017;92(6):765–70.
31. O'Neil J, Croniger C. Critical Appraisal Worksheets for Integration Into an Existing Small-Group Problem-Based Learning Curri-culum. MedEdPORTAL J Teach Learn Resour. 2018;14(2):10682.
32. Datta R, Datta K, Routh D, Bhatia JK, Yadav

AK, Singhal A, et al. Development of a portfolio framework for implementation of an outcomes-based healthcare professional education curriculum using a modified e-Delphi method. Med journal, Armed Forces India. 2021;77(1):49–56.

33. Kman NE, Thompson L, Hess J, Dora-Laskey A, Sule H, Moadel T, et al. Entrustable Professional Activity 10: Case Simulation and Assessment-STEMI With Cardiac Arrest. MedEdPORTAL J Teach Learn Resour. 2016;12(1):10517.
34. Costich M, Finkel MA, Friedman S, Catallozzi M, Gordon RJ. Transition-to-residency: pilot innovative, online case-based curriculum for medical students preparing for pediatric internships. Med Educ Online. 2021; 26(1):1892569.
35. Austin JP, Baskerville M, Bumsted T, Haedinger L, Nonas S, Pohoata E, et al. Development and evaluation of a simulation-based transition to clerkship course. Perspect Med Educ. 2020;9(6):379–84.
36. Manning MW, Bean EW, Miller AC, Templer SJ, Mackenzie RS, Richardson DM, et al. Using Medical Student Quality Improvement Projects to Promote Evidence-Based Care in the Emergency Department. West J Emerg Med. 2018;19(1):148–57.
37. Holzhausen Y, Maaz A, März M, Sehy V, Peters H. Exploring the introduction of entrustment rating scales in an existing objective structured clinical examination. BMC Med Educ. 2019;19(1):319.
38. Zackoff MW, Young D, Sahay RD, Fei L, Real FJ, Guiot A, et al. Establishing Objective Measures of Clinical Competence in Under graduate Medical Education Through Immersive Virtual Reality. Acad Pediatr. 2021;21(3):575–9.
39. Thompson LR, Leung CG, Green B, Lipps J, Schaffernocker T, Ledford C, et al. Development of an Assessment for Entrustable Professional Activity (EPA) 10: Emergent Patient Management. West J Emerg Med. 2017;18(1):35–42.
40. Dora-Laskey A, Sule H, Moadel T, Kman N, Thompson L, Hess J, et al. Entrustable Professional Activity 10: Recognizing the Acutely Ill Patient-A Delirium Simulated Case for Students in Emergency Medicine. MedEd PORTAL J Teach Learn Resour. 2016; 12 (1):10512.
41. Peters H, Holzhausen Y, Maaz A, Driessen E, Czeskleba A. Introducing an assessment tool based on a full set of end-of-training EPAs to capture the workplace performance of final-year medical students. BMC Med Educ. 2019; 19(1):207.
42. Hobday PM, Borman- Shoap E, Cullen MJ, Englander R, Murray KE. The Minnesota Method: A Learner-Driven, Entrustable Professional Activity-Based Comprehensive Program of Assessment for Medical Students. Acad Med. 2021;96(7S):50–5.
43. Imm M, Agarwal G, Zhang C, Deshpande A,

Issenberg B, Chandran L. Applying Coactivity Scales to Entrustable Professional Activity Assessments of Clerkship Students. Acad Med. 2021;96(11S):S188–9.

44. Ryan MS, Richards A, Perera R, Park YS, Stringer JK, Waterhouse E, et al. Generalizability of the Ottawa Surgical Competency Operating Room Evaluation (O-SCORE) Scale to Assess Medical Student Performance on Core EPAs in the Workplace: Findings From One Institution. Acad Med. 2021;96(8):1197-204.
45. Duggan N, Curran VR, Fairbridge NA, Deacon D, Coombs H, Stringer K, et al. Using mobile technology in assessment of entrustable professional activities in undergraduate medical education. Perspect Med Educ. 2021;10(6):373–7.