

**Practice-based Learning and Improvement (PBLI) in Postgraduate Medical Training: Milestones,
Instructional and Assessment strategies**

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ABSTRACT

Patient-safety and quality-improvement are high-priority issues. One of the ways by which this can be implemented is by training residents to gather and appraise scientific evidence, as well as to evaluate their own patient-care practices. This competency is called Practice-based Learning and Improvement (PBLI). Training in PBLI provides residents with skills and knowledge necessary to reflect on their own strengths and deficiencies, identify their own learning needs, and engage in learning for improvement. PBLI also involves teaching residents to access and integrate literature by using scientific evidence and practice experience to make better clinical decisions. Training in PBLI has been found to lead to better health outcomes. We recommend explicitly incorporating elements of PBLI training and assessment in the present residency training curriculum in India. Implementing PBLI training and assessment will also require capacity-building through targeted faculty development programs.

Keywords: *Clinical competence, Practice improvement, Residency training*

In medicine, a great deal of professional learning occurs in the authentic work- environment, where residents learn on the job, when they are exposed to real problems in daily practice [1]. One of the outcomes of training during residency is to ensure that trainees ultimately improve their patient-care practices. In order to achieve this, residents must be able to evaluate their patient-care practices, identify their strengths and deficiencies, and gather and critically analyze scientific evidence. Having done this, they must be able to set learning goals to offset their deficiencies and make feasible plans to achieve them. The Accreditation Council for Graduate Medical Education (ACGME) calls this competency Practice-based learning and improvement (PBLI) [2,3]. The ACGME believes that assessment of these competencies provide evidence of the effectiveness of the residency program and also provide information to improve it further [4]. Training in PBLI has also been shown to lead to improved health outcomes in preventive care [5], chronic disease management [6], and patient-safety [7].

The Medical Council of India (MCI) advocates that postgraduate training should be competency-based and essentially self-directed [8]. However, PBLI as a competency is not explicitly stated in this document. There is also lack of expertise in teaching and assessing PBLI in India. In teaching hospitals, the pressure of clinical work often takes priority over resident-training. While residents are expected to provide service, they must not be short-charged regarding the quality of teaching. The prevailing scenario can be improved by explicitly incorporating elements of PBLI in the residency training curriculum.

CONCEPT AND COMPONENTS

Practice based learning and improvement is best described as a cyclical continuous process (**Fig. 1**) [9]. In an attempt to link education to quality of patient care, the ACGME Outcome Project [10] defined eight constituent components under the core competency of PBLI, which are summarized in **Box 1**.

Defining Milestones

In a competency-based education and training system, the unit of progression is ‘mastery’ of specific knowledge and skills [11]. The ACGME has defined the levels of proficiency expected at each learning level [12]. Milestones have been identified for each competency, which describe the performance level of skills, knowledge or behavior that a learner is expected to demonstrate at a certain level of professional development [13]. Breaking down these competencies into observable milestones is useful both to the learner and to the assessor as they help in determining an individual learner’s trajectory from a beginner to a proficient practitioner.

ACGME suggests writing five levels of milestones [14] based on the Dreyfus model of skill development [15]. We have already discussed these levels in an earlier paper [16]. Milestones have been defined specifically for different clinical specialties [11]. For Pediatrics, milestones under different components of PBLI have been defined in several ways [17-22]. **Web Table I** illustrates different milestones under each competency and provides practical examples of these.

Each of these PBLI competencies are discussed in detail below:

1. Identify strengths, deficiencies and limits in one’s knowledge and expertise

Learners may be able to identify their deficiencies and limits because they are either: Motivated by external threat of a negative consequence; *e.g.* punishment, morbidity, bad grades; or Motivated by external positive consequence; *e.g.* reward, good scores in examination, praise from superior; or Intrinsically motivated by reward: such as ease of work, comfort, satisfaction of learning; or Intrinsically motivated to excel and acquire expertise.

Identification of gaps serves as a stimulus to identify their strengths and limitations in performance, by working hard to master skills against required standards. Kolb [23] suggests that when learners perceive gaps in knowledge, skills and attitudes on reflecting on their experiences, they tend to engage in active experimentation like applying new strategies to learn further. Schon’s model talks of the importance of reflection either before (“reflection for action”) or during (“reflection in action”) or after a particular action (“reflection on action”) [24]. This pushes learners to seek new knowledge in ambiguous situations and incorporate new knowledge into practice.

2. Set learning and improvement goals

Self-directed learning is a process in which “individuals take initiative (with or without the help of others) to diagnose their own learning needs, formulate goals, identify human and material resources for learning,

choose and implement appropriate learning strategies and evaluate learning outcomes” [25]. This task requires them to formulate both short-term and long-term learning and improvement goals. Triggers to discovering new learning needs can be: questions which arise during patient care, while reading, during conversations with other peers or while attending formal academic sessions. Self-directedness is influenced by factors such as motivation, self-regulation and self-efficacy [26].

3. Identify and perform appropriate learning activities for personal and professional development

Learners must be aware of their preferred learning styles [23] and must have sufficient understanding of what they need to learn (in terms of knowledge, skills, behavioral change). They also need to know what instructional methods most effectively and efficiently address their specific learning needs and where they can access these resources. This may require considerable discussion, consultation and trial-and-error before identification of strategies that work best for them.

4. Incorporate formative evaluation feedback into daily practice

Formative feedback intends to improve specific aspects of a learner’s performance by offering insight into their behavior, rather than offering a judgment on overall performance [27]. Learners must eventually learn not only to listen to feedback and incorporate it into their practice, but also be proactive in seeking feedback for improvement. In practice, a learner must be aware of his limitations and must know when a situation requires him to summon help from a superior without compromising the safety of a patient.

5. Systematically analyze practice using quality improvement methods and implement changes

Residents are expected to be able to apply their knowledge of desired standards of patient care, standard protocols, evidence-based guidelines and principles of quality improvement in their day-to-day practice. They need to imbibe reflective practice and learn how to manage change. If individuals are not trained in reflective practice, they may turn defensive, when shown evidence for their need to improve. In early stages, their focus might be on individual patients. However, in the long run, clinicians will need to shift their focus to their teams and to the system [28]. This can be taught by integrating residents in the team which is involved in the hospital’s quality improvement programs [29]. For example, an effort to improve the care of low birth weight babies should also include attention to the system – like the process of recording weight, record keeping, training of nurses and other care providers, provision of nutritional advice and availability of educational material.

6. Locate, appraise, and assimilate evidence from scientific studies related to health problems of patients

The amount of medical information is ever-increasing and clinicians must learn strategies to search for the evidence and apply it in their practice [30]. Confronted with uncertainty in a clinical case, the learner must be able to actively question the rationale of patient care. For example; *‘In this patient, what is the best antibiotic we should be using? What is the evidence we have for this decision?’*

One cannot practice evidence-based medicine (EBM) without being able to set improvement goals for oneself or without being motivated to be a lifelong learner. The skills required to be learnt in order to practice have been detailed previously [17].

The milestones which characterize learners in various stages of development of this sub-competency are illustrated through examples in **Web Table I**. Learning EBM needs a steep learning curve and a methodical approach. Several authors suggest introducing EBM to undergraduates when time constraints are less. These skills can subsequently be strengthened through actual practice during residency training.

7. Use information technology to optimize learning and health care delivery

Information technology is now vital to the practice of medicine. The availability of the internet, the adoption of hospital information systems and electronic health records (EHR) and use of technology such as Tablets and Smartphones to provide access to information at the point of care have changed the way in which clinical medicine is practiced [31]. Medical colleges also have invested majorly in computers and internet access.

Acceptance of technology is affected by perceived ease of use and perceived usefulness. Of these, the perceived ease of use has a greater impact on behavior and early learners must overcome this hurdle to adopt technology [32,33]. While training new learners it is important to keep in mind the following factors which determine early perceptions of ease of use of a new system [34]:

- *Internal control*: Characterized by one's own sense of savviness with technology.
- *External control*: Perception of support from facilitators with use of the new technology.
- *Intrinsic motivation*: Characterized by 'computer playfulness' or intrinsic enjoyment in interacting with the technology.
- *Emotion*: Computer anxiety or negative reaction to use of computers.

8. Participate in the education of patients, families, fellow students and other health care professionals

Patient-education requires several skills and capabilities such as: knowledge about the disease process, counseling skills, interpersonal and communication skills. Learners must be trained in carrying out interactive, two-way, patient-centered counseling sessions, while paying special attention to the behavioral, psychosocial and environmental attributes of health and disease [35,36]. They must be able to perform data gathering, educate the patient, negotiate and resolve issues, and demonstrate empathy [37].

INSTRUCTIONAL STRATEGIES TO IMPART TRAINING IN PBLI

Teaching the competency of PBLI may require different pedagogical strategies compared to those used to foster clinical-reasoning skills or patient-interaction skills. The basic principles of designing these strategies are to clearly define key learning outcomes, identify potential workplace settings which can be

opportunistically used to impart PBLI competencies and select engaging and learning-rich experiences. The developmental milestones enumerated in **Web Table I** will be useful to identify the level of the learner and build on previous learning.

Learners must be encouraged to use both formal and informal approaches. Some of these approaches are: use of study groups with peers, problem solving exercises, formal clinical rotations, online modules (for knowledge); demonstrations, simulations, review of video recording of learner, deliberate practice (for skills); and sharing real life experiences in discussions, behavioral interventions, and appropriate role models (for behavior). Deliberate practice involves improving and extending the reach and range of skills which one already possesses. Deliberate practice entails considerable, specific and sustained efforts to develop expertise in something which the learner cannot do well [38].

Literature has documented many teaching-learning strategies ranging from small-group learning [39], workshops [40] to project-based learning [41], which can help in fostering these behaviors in learners. Many curricula and models have also been developed and tested [42-44]. Some of the best documented instructional strategies for cultivating PBLI behaviors in learners have been documented in the ACGME project report [45] and are summarized in **Fig.2**. Some of these instructional strategies are elaborated below:

Case based approaches:

A case, problem or inquiry is used to stimulate discussion and impart learning. Based upon the level and nature of inquiry, residents' discussion can be observed, analyzed, evaluated and critiqued as it reflects their level of knowledge, skills, and attitudes. Probing can divulge the existing status of knowledge as well as resident's ability to recognize learning gaps. Some of the case based approaches are inquiry based learning, morning rounds, exit rounds, and clinical chart review.

- *Inquiry based learning*: This model helps learners develop the habit of inquiry by asking questions. These questions may be posed to themselves or to other learners in the group, thus fostering self-directed and autonomous learning. Learners not only try to search for the right answers, but also identify the gaps in their learning as far as knowledge and skills are concerned and help to address them. This can be in the form of reciprocal peer questioning. The model works on the presumption that if critical thinkers are good questioners, the reverse is also true. This helps in promoting skills of critical analysis and appraisal [46].
- *Morning rounds*: Cases providing learning opportunities can be chosen and patient-care can be reviewed during rounds, with residents and students being asked to prepare possible queries about the case. To widen the areas of learning opportunities and improving the patient-care, case audits and case-census can also be assimilated into the whole exercise [47].

- *Exit rounds:* Exit rounds tap the opportunity of learning provided by recently discharged patients. Residents reflect on the learning they have while working with these patients. This provides with an opportunity to improve their patient care practices too. Besides being a learning exercise, exit rounds offer attending physicians an opportunity to evaluate students' learning and performances [48].
- *Clinical-chart review:* A chart review involves a systematic analysis of what has been done in the course of clinical care of a patient, and how this could have been done better. Patient chart review can help residents in identifying the areas where they need improvement; gaps in their patient care practice, and help them in taking critical action to improve their patient outcomes. This exercise improves self-assessment and critical analytical skills [43].

Morbidity and mortality audit

A *morbidity and mortality* audit is a specific audit that tends to review negative clinical outcomes. A bizarre audit finding can act as a lead and can direct further investigation into practice patterns [49]. The resident scrutinizes morbidity and mortality case in terms of his or her own practice behaviors, reflects on it, and uses that to improve practice behavior [43,50]. The resident presents a description of the case, reflections on what went wrong, and a list of resources used to gain a better understanding of the case. Presenters are expected to challenge themselves with self-queries like what they would do differently and what they would have to learn in order to improve. Clinical teachers' rate residents in areas of practice analysis, improvement opportunity, resources to support analysis, and action plan [50].

Structured-tutorials: A case under a resident's care, which generated uncertainty either during evaluation or management or counseling and which definitely requires some action is chosen. The resident discusses the case with a facilitator. Then a Medline search is conducted by the resident for relevant literature review. Again a meeting with facilitator is conducted and a tutorial is prepared. The same is presented to the group in a structured-manner, giving questioning opportunities after every session [51]. By utilizing their own clinical cases, the residents appreciate the need to learn, identify learning-gaps, and improve by self-reflection on real life situations, thus improving PBLI skills.

Project-based learning: Residents work with a facilitator to recognize an area of their practice that needs improvement, plan a project-intervention to improve upon that gap, execute the improvement, and establish its efficacy of the implementation during next year. By learning their own practice-gaps and improving upon by self-reflection, and implementation of improvement-project, the residents inculcate PBLI skills [52].

Journal clubs: The focus of journal clubs can be one specific skill (such as how to use likelihood ratios, or how a search strategy is developed), and then specific articles can be chosen to teach that

particular skill. Residents must eventually learn how to weigh the strength of the scientific evidence and regular sessions on critical appraisal of journal articles are most valuable for this purpose.

While PBLI needs to be explicitly included in the postgraduate training program, it can be introduced early in the undergraduate curriculum with Early clinical exposure (ECE); using student electives to reinforce the value of evidence-based medicine; and by allowing undergraduates to shadow patients in the clinics.

ASSESSMENT OF PBLI COMPETENCIES

Assessment of PBLI as a whole is difficult as it spans different roles of a scholar, professional, manager, communicator, and lifelong learner. It is not possible to measure all competencies with a single assessment tool. Lack of validated and reliable tools to assess this competency compounds the problem. Dependable methods of assessment must be developed. By defining milestones for each competency, assessment criteria specify the level of achievement or mastery expected at each stage. During assessment, the rate of progress of the learner's knowledge, skills and behavior on each competency must be documented.

Assessment of PBLI involves longitudinal observation of the learner demonstrating self-directed learning behaviors, during multiple encounters [17]. One option to demonstrate improvement is to use the same assessment tool at different points along the training, provided that the tool is able to consistently distinguish between the different levels of performance.

It is important to clarify what will be assessed, how and when the assessment will be conducted and who will be responsible for assessment. Assessment can both be formative as well as summative. Some of the approaches which have been used to assess PBLI are detailed below:

Portfolios: Residents in most institutes in India, use pre-formatted logbooks as a popular means to document learning experiences in patient care. These are seldom taken seriously and scarcely provide opportunities of reflective behavior, feedback and improvement in patient care. Portfolios are a compilation of one's professional work and achievements over a period of time and can be used to assess progress. Self-reflection is the inherent characteristic of any portfolio-linked learning and professional development, and that's where they differ from logbooks, which are merely a compilation of record of one's work [53]. Reviewing and analyzing a portfolio along with a mentor is a good strategy for a resident to receive formative feedback [54]. Portfolios can also be maintained electronically to track learner progress. The flexibility, comprehensiveness and potential for integration offered by use of portfolios makes it a top choice for assessment of PBLI competencies [9].

Medical record review and Chart-stimulated recall: Patient records are reviewed during one-on-one sessions with faculty in formal or informal settings using standardized forms. The focus of the review can

be resident's decision making, medications given, tests ordered, impact of interventions and their comparisons with standard patient care guidelines.

Performance ratings using checklists or global rating forms: Global assessment of competencies using rubrics or observation checklists may be other methods of demonstrating progress of learners [2,13]. Rubrics must clearly show how the learner has moved to a higher level of performance on each competency. Checklists are useful when competencies can be broken down into specific behaviors or actions. Each clinical encounter requires enlisting of determined standards before assessment can be implemented. Both checklists and rubrics require trained raters to assess completeness and correctness of each outcome.

Procedure or case logs: Residents prepare summaries of patient care experiences or procedures, which include both clinical data as well as their reflections [2]. These logs are useful for documentation of experiences and deficiencies, and can form part of the portfolio. Review of these logs with a faculty can be used to assess PBLI competencies.

Evidence-based medicine skill test: Some residency programs use written or oral EBM skill tests to assess knowledge of critical appraisal. Different abilities—such as formulating well-structured clinical questions; performing advanced literature searches; and assessing validity of evidence in published studies can be tested. The EBM skill test can be conducted several times; once before exposure to EBM curriculum and after that to record improvement in learning. Sustainability of improved behavior can be also assessed with EBM skill tests [55].

Other methods: Multiple choice questions, oral examination, use of standardized patients, objective structured clinical examination, work-place based assessment [56] like mini-clinical evaluation exercise (mini-CEX), 360° assessment and direct observation of procedural skills (DOPS), can be used for formative and summative assessment of PBLI. During 360° assessment or multisource feedback, residents receive structured feedback using standard forms from their peers, faculty, nurses, other staff and patients who observe their work on a day-to-day basis during patient care. Feedback maybe gathered on different aspects of their performance such as team work, professionalism, communication skills, management skills or decision making. These assessment forms could form part of the educational portfolio. In all these methods, direct observation of the learner in the workplace is followed by opportunities for reflection when constructive feedback is given by the faculty.

ROLE OF FACULTY AND FACULTY DEVELOPMENT

While we cannot emphasize the role of faculty in nurturing these skills enough, it must be said that strong institutional leadership and support are the keys to the effective implementation of these competencies. A

rigid regulatory framework, shortage of faculty, unenthusiastic or overworked faculty, or lack of resources are all possible impediments to the successful functioning of this programme.

Faculty is required to guide and nurture learners to be self-directed [57]. Faculty or supervisors will be required to assist learners in envisioning long-term broader goals and then breaking them down into more achievable feasible short-term goals within a given time frame. It is important for faculty in each department to diagnose the stage of self-directedness that the learner lies in, so that they can facilitate their movement from a less advanced to a more advanced stage [58].

Faculty must be made aware of the importance of ensuring that students are trained and assessed for the competencies under PBLI. Faculty sensitization and training will be required to identify opportunities within the existing curriculum to incorporate PBLI training, provide constructive formative feedback, documentation of progress of milestones achieved by students in a longitudinal manner and assessment of competencies of PBLI. Ownership must be shared by several collaborators.

The development of expertise requires faculty who have the patience to observe students in their day-to-day work, and who have the capability of delivering constructive, and sometimes difficult feedback to the learner. Feedback which comes from a supervisor who has directly observed the learner is always more acceptable. To provide optimal feedback, faculty need to articulate it in a simple manner and provide clear messages, facilitate reflection and guide learners on how to translate learning goals into action [59]. Faculty must also have the ability to mentor, support and challenge learners in a manner that they are driven to achieve the next milestone. For skill acquisition, it is useful here to remember that there will be variations in how learners progress and acquire more advanced skills [15]. They must be given enough guidance, feedback, experience and practice to be comfortable with newer technologies.

CONCLUSION

Residents must be provided with ample opportunities to experience and practice their skills, in order to move towards acquiring expertise and acquire the competencies under practice based learning and improvement. It is important that they develop self-awareness of their abilities, are able to reflect on their proficiency and find avenues to pursue lifelong learning. Training and assessment of PBLI skills should be a mandatory part of the postgraduate curriculum and strategies to foster PBLI skills should be interwoven within all phases of training. Availability of milestones makes this process feasible enough to implement in practice.

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REFERENCES

1. Spencer J. Learning and teaching in the clinical environment. *Br Med J.* 2003;326:591-4.
2. Hayden SR, Dufel S, Shih R. Definitions and competencies for practice-based learning and improvement. *Acad Emerg Med.* 2002;9:1242-8.
3. Varkey P, Karlapudi S, Rose S, Nelson R, Warner M. A systems approach for implementing practice-based learning and improvement and systems-based practice in graduate medical education. *Acad Med.* 2009;84:335-9.
4. Swing SR. Assessing the ACGME general competencies: General considerations and assessment methods. *Acad Emerg Med.* 2002;9:1278-88.
5. Paukert JL, Chumley-Jones HS, Littlefield JH. Do peer chart audits improve residents' performance in providing preventive care. *Acad Med.* 2003; 78 (suppl 10):S39-41.
6. Sutherland JE, Hoehns JD, O'Donnell B, Wiblin RT. Diabetes management quality improvement in a family medicine residency program. *J Am Board Fam Pract.* 2001;14:243-51.
7. Parenti CM, Lederle FA, Impola CL, Peterson LR. Reduction of unnecessary intravenous catheter use: Internal medicine house staff participate in a successful quality improvement project. *Arch Intern Med.* 1994;154:1829-32.
8. Medical Council of India. Post Graduate Medical Education Regulations 2000. Available from: <http://www.mciindia.org/RulesandRegulations/PGMedicalEducationRegulations2000.aspx>. Accessed 17 July, 2016.
9. Lynch DC, Swing SR, Horowitz SD, Holt K, Messer JV. Assessing practice-based learning and improvement. *Teach Learn Med.* 2004; 16: 85-92.
10. Swing SR. The ACGME outcome project: retrospective and prospective. *Med Teacher.* 2007;29:648-54.
11. Sullivan RL. The Competency-based Approach to Training. Strategy Paper No 1. JHPIEGO Corporation: Baltimore, Maryland; 1995. Available from: http://pdf.usaid.gov/pdf_docs/Pnacg569.pdf. Accessed 17 July, 2016.
12. Nasca T. The next step in the outcomes-based accreditation project. *ACGME Bull.* 2008;2-4.
13. Swing SR, Beeson MS, Carraccio C, Coburn M, Lobst W, Selden NR, *et al.* Educational milestone development in the first 7 specialties to enter the next accreditation system. *J Grad Med Educ.* 2013;5:98-106.
14. Holmboe ES, Edgar L, Hamstra S. ACGME: The Milestones Guidebook; Version 2016. Available from: <https://www.acgme.org/Portals/0/MilestonesGuidebook.pdf>. Accessed 17 July, 2016.

15. Dreyfus HL, Dreyfus SE. *Mind over Machine*. New York, NY: Free Press; 1988.
16. Dhaliwal U, Gupta P, Singh T. Entrustable professional activities: Teaching and assessing clinical competence. *Indian Pediatr*. 2015; 52: 591-7.
17. Burke AE, Benson B, Englander R, Carraccio C, Hicks PJ. Domain of competence: Practice-based learning and improvement. *Acad Pediatr*. 2014; 14: S38-S54.
18. Hicks PJ, Schumacher DJ, Benson BJ, Burke AE, Englander R, Guralnick S, *et al*. The pediatrics milestones: conceptual framework, guiding principles, and approach to development. *J Grad Med Educ*. 2010; 2:410-8.
19. American Board of Pediatrics and Accreditation Council for Graduate Medical Education. The Pediatrics Milestone Project. Available from: <https://www.abp.org/abpwebsite/publicat/milestones.pdf>. Accessed 17 July, 2016.
20. Englander R, Burke A, Guralnick S, Benson B, Hicks PJ, Ludwing S, *et al*. The pediatric milestones: a continuous quality improvement project is launched-now the hard work begins! *Acad Pediatr*. 2012;12:471-4.
21. Hicks PJ, Englander R, Schumacher DJ, Burke A, Benson BJ, Gurulnick S, *et al*. Pediatrics milestone project: next steps toward meaningful outcomes assessment. *J Grad Med Educ*. 2010;2:577-84.
22. Schumacher DJ, Lewis KO, Burke AE, Smith ML, Schumacher JB, Pitman MA, *et al*. The pediatrics milestones: initial evidence for their use as learning roadmaps for residents. *Acad Pediatr*. 2013;13:40-7.
23. Kolb D. *Experiential Learning as the Science of Learning and Development*. Englewood Cliffs, NJ: Prentice Hall; 1984.
24. Schon D. *Educating the Reflective Practitioner*. San Francisco, Calif: Jossey-Bass Publishers; 1987.
25. Knowles MS. *Self-Directed Learning. A Guide for Learners and Teachers*. Englewood Cliffs: Prentice Hall/Cambridge; 1975.
26. Morris C, Blaney D. *Work-Based Learning*. In: Swanwick T, (editor). *Understanding Medical Education: Evidence, Theory and Practice*. Wiley-Blackwell: Oxford, UK; 2010.
27. Ende J. Feedback in clinical medical education. *JAMA*. 1983;250:777-81.
28. Moore LG, Wasson JH. Improving efficiency, quality and the doctor-patient relationship. *Fam Pract Manag*. 2007;14:20-4.
29. Ashton CM. "Invisible doctors": making a case for involving medical residents in hospital quality improvement programs. *Acad Med*. 1993;68:823-4.

30. Sackett DL, Rosenberg WM, Muir Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. *BMJ*. 1996;312:71-2.
31. Duncan J, Evens R. Using information to optimize medical outcomes. *JAMA*. 2009;301:2383-5.
32. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q*. 1989;13:319-39.
33. Davis FD, Bagozzi RP, Warshaw PR. User acceptance of computer technology: a comparison of two theoretical models. *Manage Sci*. 1989;35:982-1002.
34. Venkatesh V. Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Inf Syst Res*. 2000;11:342-65.
35. Bird J, Cohen-Cole SA. The three function model of the medical interview. An educational device. *Adv Psychosom Med*. 1990;20:65-88.
36. Lazare A, Putnam SM, Lipkin M. Jr. Three functions of the medical interview. *In: Lipkin M Jr., Putnam SM, Lazare A, editors. The Medical Interview: Clinical Care, Education, and Research. New York, NY: Springer-Verlag; 1995. p. 3-19.*
37. Modi JN, Anshu, Chhatwal J, Gupta P, Singh T. Teaching and assessing communication skills in medical undergraduate training. *Indian Pediatr*. 2016;53: 497-504.
38. Ericsson KA, Prietula MJ, Cokely ET. The making of an expert. *Harv Bus Rev*. 2007;85:114-21.
39. Canal DF, Torbeck L, Djuricich AM. Practice-based learning and improvement: a curriculum in continuous quality improvement for surgery residents. *Arch Surg*. 2007;142:479-83.
40. Morrison LJ, Headrick LA. Teaching residents about practice-based learning and improvement. *Jt Comm J Qual Patient Saf*. 2008;34:453-9.
41. Ogrinc G, Headrick LA, Morrison LJ, Foster T. Teaching and assessing resident competence in practice-based learning and improvement. *J Gen Intern Med*. 2004;19 496-500.
42. Peters AS, Kimura J, Ladden JD, March E, Moore GT. A self-instructional model to teach systems-based practice and practice-based learning and improvement. *J Gen Intern Med*. 2008;23:931-6.
43. Ziegelstein RC, Fiebach NH. The mirror and the village: A new method for teaching practice-based learning and improvement and systems-based practice. *Acad Med*. 2004;79:83-8.
44. Tomolo AM, Lawrence RH, Watts B, Augustine S, Aron DC, Singh MK. Pilot study evaluating a practice-based learning and improvement curriculum focusing on the development of system-level quality improvement skills. *J Grad Med Educ*. 2011;3:49-58.
45. ACGME Outcome Project. Enhancing residency education through outcomes assessment - Advancing education in practice-based learning and improvement. Available from:

https://www.usahealthsystem.com/workfiles/com_docs/gme/2011%20Links/Practice%20Based%20Learning.ACGME.pdf. Accessed July 17, 2016.

46. King A. Designing the instructional process to enhance critical thinking across the curriculum. *Teach Psychol.* 1995;22:13-7.
47. Whelan CT, Podrazik PM, Johnson JK. A case based approach to teaching practice-based learning and improvement on the wards. *Semin Med Pract.* 2005; 8:64-74.
48. Arseneau R. Exit rounds: A reflection exercise. *Acad Med.* 1995;70:684-7.
49. Yaffe MJ, Gupta G, Still S, Boillat M, Russillio B, Schiff B, *et al.* Morbidity and mortality audits. *Can Fam Physician.* 2005;51:234-9.
50. Rosenfeld JC. Using the morbidity and mortality conference to teach and assess the ACGME general competencies. *Curr Surg.* 2005;62:664-9.
51. Green ML, Ellis PJ. Impact of an evidence-based medicine curriculum based on adult learning theory. *J Gen Intern Med.* 1997;12:742-50.
52. Lough JRM, Murray TS. Audit and summative assessment: a completed audit cycle. *Med Educ.* 2001;35:357-63.
53. Joshi M, Gupta P, Singh T. Portfolio-based learning and assessment. *Indian Pediatr.* 2015;52:231-5.
54. Salzman DH, Franzen DS, Leone KA, Kessler CS. Assessing practice-based learning and improvement. *Acad Emerg Med.* 2012;19:1403-10.
55. Smith CA, Ganschow PS, Reilly BM. Teaching residents evidence-based medicine skills: a controlled trial of effectiveness and assessment of durability. *J Gen Intern Med.* 2000;15:710-5.
56. Singh T, Modi JN. Workplace-based assessment: A step to promote competency based postgraduate training. *Indian Pediatr.* 2013;50:553-9.
57. Schmidt H. Assumptions underlying self-directed learning may be false. *Med Educ.* 2000;34:243-5.
58. Grow GO. Teaching learners to be self-directed. *Adult Educ Q.* 1991;41:125-49.
59. Nichol DJ, Macfarlane-Dick D. Formative assessment and self-regulated learning: a model and seven principles for good feedback practice. *Stud Higher Educ.* 2006;31:199-218.

WEB TABLE 1 COMPETENCIES AND MILESTONES FOR PRACTICE BASED LEARNING AND IMPROVEMENT

<i>Components of PBLI [10]</i>	<i>Developmental milestones which can be used for teaching and assessment purposes [17-22]</i>	<i>Practical example of attainment of milestone</i>
Identify strengths, deficiencies and limits in your knowledge and skills	1. Understands own performance in terms of grades, but has little understanding of own strengths and limitations	The learner is able to tell how much he has scored, without actually being able to interpret the real meaning of the grades
	2. Assesses own performance on the basis of ability to perform a task. Does not care about how well the task was done	Does not ask feedback about how well something was done or why something happened
	3. Seeks to identify gaps in knowledge, skills and attitudes to handle common clinical situations	Asks questions such as: Which is the best antibiotic to be given in a 2 year old child with pneumonia? What are the consequences of giving antiemetics in a child with diarrhea?
	4. Seeks to identify gaps in knowledge, skills, and attitudes based on self-reflection. Advanced level of questioning and resource seeking skills used	When learner encounters a case he has never seen before, he tries to correlate pathophysiology with clinical findings to understand course of disease, and confirms his assumptions with available resources
	5. Seeks to expand knowledge, skills and attitudes beyond what is immediately required and seeks to achieve expertise	Asks questions such: as why zinc supplementation is advised only to children below 5 years of age with diarrhea?
Set goals for learning and improvement	1. Constructs learning goals at 'how-to' level, These are triggered based on acute needs of his patients	The learner needs to take the history of a patient with nephrotic syndrome. Using protocols from textbooks, the learner lists relevant questions to obtain history in a child with nephrotic syndrome (addresses gaps in learning)
	2. Formulate learning goals to address gaps identified in the context of health care delivery. These are reinforced by peers, faculty etc	When managing a case of nephrotic syndrome, the resident needs to know the dose of steroid required. It also makes him think about the pathophysiology of the case and find out how steroids are useful in the management of these patients.
	3. Constructs learning goals needed in hypothetical or which were previously encountered cases	The resident retrieves a systematic review for management of nephrotic syndrome and tries to understand variations in management according to underlying etiology

	4. Constructs learning goals which enable learner to teach others.	The learner tries to correlate clinical and diagnostic findings with the mechanism of disease, clarifying his understanding. This enables him to explain things to others.
	5. Identifies multiple learning goals as a habit, including broader areas such as professionalism in the learning goals	The resident realizes that he has to acquire counseling skills if he expects patients to comply with the management plan
Identify learning activities suited for your personal and professional development, and execute them	1. Engages in learning activities from readily available resources or curricular materials regardless of appropriateness to activity or outcome	Asks senior colleague what medication to give a particular patient rather than reading from an authentic reference source
	2. Engages in learning activities that are prescribed or assigned by others	Before attending a scheduled clinical session, resident specifically reads about cases allotted to him
	3. Seeks learning resources based on own learning needs, after considering nature of content and method required	Having failed at intubation, goes back to simulation centre to practice skills on mannequin rather than merely reading written protocols.
Incorporate formative evaluation feedback into daily practice	1. Inability to incorporate formative feedback into daily practice	The resident has difficulty in accepting his lacunae as pointed by others; Avoids feedback
	2. Is dependent on external sources of feedback for improvement; Listens to feedback, but takes away only those messages that he wants to hear	Resident begins to acknowledge other's points of view. However reinterprets feedback in a way that it serves his own need for praise or consequence avoidance. Not much behavioral change occurs in response to feedback
	3. Understands others' points of view; alters behavior to improve specific deficiencies noted by others	When faculty tells the resident that he was not clear in providing instructions to a patient, he is able to look back and examine what prompted that perception, even when he disagrees with that perception
	4. Improves daily practice on the basis of external formative feedback and internal insights	Learner is able to point out what went well and what did not go well (in the given task); and is able to make positive changes in behavior as a result
	5. Demonstrates professional maturity and emotional commitment resulting in continuous reflection and self-regulation	The learner is able to focus not only on deficiencies, but also on strengths and is able to chart out his own path for improvement
Analyze your practice in a systematic manner (using	1. Unable to gain insight from patient experience due to inability to reflect on practice/ Does not understand concepts of quality improvement	Gets defensive when confronted with evidence that there is need to improve performance

tools for improving the quality), and change your practice accordingly (to improve the quality)	methodology or change management	
	2. Able to gain insight from reflection on patient encounters; but does not have systemic improvement strategies and team approach	Is able to see need for improvement; but needs faculty guidance to choose resources or instructional methods to overcome these gaps
	3. Able to gain insight for improvement from reflection, both from individual patients as well as populations	Identifies the need to make improvements to the system to improve practice. But needs external guidance to prioritize improvement opportunities or to make actual change happen in the system
	4. Able to use individual patient encounters and population data to improve things using the right methodology	The resident is able to analyze own patient care data, and make improvements in an iterative fashion without external guidance. Is able to lead a team in improving quality of patient care and service
	5. Demonstrates continuous improvement activities; utilizes quality improvement methodologies	Is able to use own individual experience to improve other practices, systems or populations. Is open to analysis and course correction to optimize improvement
Find, appraise, and synthesize evidence from peer-reviewed literature, concerned with problems your encounter	1. Explains basic principles of evidence-based medicine (EBM), but does not understand its clinical relevance	The learner is unable to convert knowledge gaps into an answerable research question. He is unable to retrieve information pertinent to a particular clinical context. May use general search engines like Google to gather low level evidence
	2. Recognizes importance of using latest information but his ability to search literature is not efficient enough	Learner is able to frame a question in Population-Intervention-Comparison-Outcome (PICO) format. However since he finds literature search time consuming, he is usually unprepared with the answers to clinical questions
	3. Is able to use literature search methods; and to critically appraise literature with some guidance	Learner is able also to search literature efficiently by using proper search strategy. Can retrieve high quality evidence but has some difficulty in applying this evidence in practice
	4. Incorporates use of clinical evidence in complex clinical decision making for the benefit of his patients	Learner is proactive in formulating more questions in response to the original question. He is able to critically appraise different types of clinical studies. He shares what he learns with other team members and is able to apply evidence to his

		patients
	5. Teaches critical appraisal to others. Applies his understanding of EBM to his patients routinely	Learner is an EBM practitioner who is emulated by other colleagues, who see him as a role model. He helps team members to develop and refine their skills with his expertise
Use information technology for maximizing learning and delivery of health care	1. Displays resistance to adopting new technology	Learner uses information technology only when it is made mandatory and requires direct supervision
	2. Demonstrates willingness to try new technology	Learner is able to use the technology efficiently for learning.
	3. Is able to use information technology for clinical decision making	Is able to retrieve biomedical information efficiently and apply it to take decisions for patient care
	4. Consistently uses evidence based decision support tools to supplement clinical experience	Learner is familiar with information technology resources and uses them consistently to answer clinical questions identified during patient care
	5. Engages in continuous improvement of systems to make technology innovations in patient care and learning	In addition to the above milestones, the learner tries to bring about innovative changes using technology to simplify the systems for patient care
Educate your patients, their families, fellow students and other health care professionals	1. Engages in doctor-centered interaction	The learner adheres to a scripted type of patient counseling due to lack of knowledge and experience, which may not meet the needs of a patient
	2. Shifts between doctor-centered and patient-centered interaction depending on circumstances	The learner demonstrates flexibility in patient counseling, in a manner that meets patient needs. He is aware of patient's educational status and is responsive to patient's questions
	3. Has both knowledge and experience in counseling and is typically patient-centered	The learner checks for patient's understanding when there seems to be confusion. He is able to modify counseling strategies in complex circumstances
	4. Counseling is patient-centered and efforts are made to empower and motivate patients	Facilitates participation of patients in all discussions about their health. Uses flexible strategies in patient education
	5. Demonstrates seamless interaction and skillful counseling ability with all kinds of patients, being patient-centered	Patients return satisfied with the counseling session and feel motivated to comply with the medical advice



Fig. 1: *Cycle of practice-based learning and improvement*

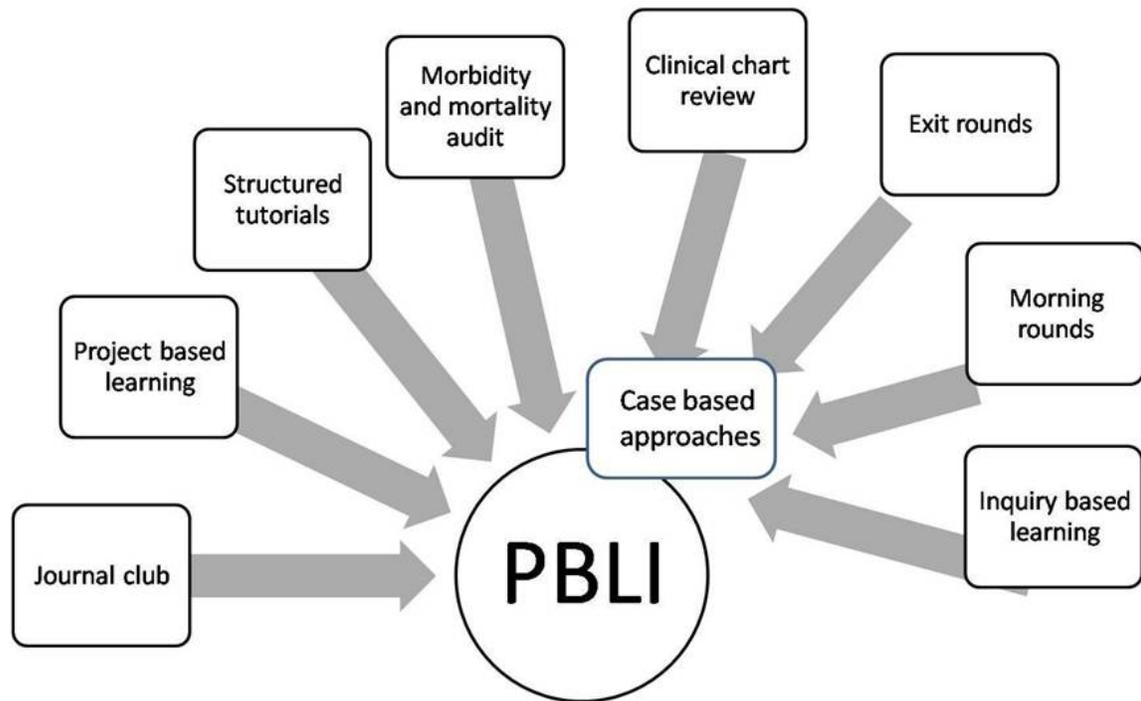


Fig.2: Teaching-learning strategies to cultivate practice-based learning and improvement behaviors in learners

Box 1: ACGME COMPONENTS OF PRACTICE-BASED LEARNING AND IMPROVEMENT

In order to acquire the core competency of practice-based learning and improvement, the learner should be able to:

1. Identify strengths, deficiencies and limits in one's knowledge and expertise
2. Set learning and improvement goals
3. Identify and perform appropriate learning activities for personal and professional development
4. Incorporate formative evaluation feedback into daily practice
5. Systematically analyze practice and implement changes to improve practice
6. Locate, appraise, and assimilate evidence from scientific studies
7. Use technology to optimize learning and health care delivery
8. Participate in the education of patients, families, fellow students and other health care professionals

Source: Swing SR. The ACGME outcome project: retrospective and prospective. Med Teacher. 2007; 29: 648–54.