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SHORT COMMUNICATION

# Patient-Centered Team-Based Learning in Pre-Clinical Curriculum Supporting the Application of Knowledge to Real-World Clinical Experience

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**Abstract**
We report an active learning session which effectively supported 1st year medical students applying their learning experience in a clinical setting. A team-based learning (TBL) on familial hypercholesterolemia (FH) with a live patient was given to deliver basic genetics knowledge in a clinically relevant context. Subsequently, two participating students applied their learning experience by presenting a differential diagnosis of homozygous FH in a patient at a medical mission in Central America. We propose that combining active learning with clinically relevant scenarios effectively fosters student's clinical reasoning skills and can bridge the perceived gap between basic science and clinical education.

**Keywords** Undergraduate medical education · Basic science curriculum · Team-based learning · Patient-centered case · Familial hypercholesterolemia · Medical mission

## Background

The role of basic science education in undergraduate medical school curriculum has been actively debated [1]. A major question is how to effectively translate basic science concepts into clinical reasoning skills [2]. This is a challenging objective, especially because first-year medical students have limited clinical experience. Nonetheless, basic science courses have made strides to this end by applying a variety of learner-centered modalities [3–6].

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At the University of California, Davis, preclinical courses are offered during the first two years of curriculum: 1st year foundation science courses offering basic science principles of human health and 2nd year pathophysiology, organ-based courses. To increase the clinical relevance of basic science content, the use of active learning has been expanding in the preclinical curriculum. This report describes one such effort in a 1st year genetics course in which patient-centered cases were delivered using TBL [7–9]. It has been recognized that the use of clinical cases enhances student learning experience [10] and that case-based TBL improves students' academic performance [11, 12]. Here, we aimed to bridge the perceived gap between basic science curriculum and clinical practice using case-based TBL, whose framework emphasizes promoting deep learning through application of previously acquired knowledge to problem solving [9, 13, 14]. The resultant TBL subsequently supported two participating students' applying the TBL experience to a real patient encounter, further reinforcing the efficacy of TBL in integrating basic science knowledge and clinical reasoning.

## Activity

The details of the session are described in the Supplemental Materials. Briefly, the 2-hour TBL was structured with 18 teams of 6–7 students (120 students total). Six facilitators were present. In the place of the advance assignment, the lectures relevant to the TBL were listed for students to review and mastery of the contents was assessed by individual readiness assessment test (IRAT) administered via the course website. Three vignette style FH cases were made available to students at the beginning of the TBL. During a team-based learning period, students practiced clinical reasoning by applying knowledge previously acquired in the lectures as well as information obtained from medical genetics databases. Subsequently, randomly selected teams presented possible diagnosis, risk assessment, and FH patient management plans to the class.

## Results and Discussion

### a. Learning Content of the TBL

The TBL cases were created to support the critical physician competencies in genomic medicine including recognizing patterns of inheritance, formulating a genetic testing strategy, and recommending patient management based on the testing results [15]. We chose FH for the cases because: 1) it is one of the most common genetic diseases in the general population (1 in 200-250), yet grossly underdiagnosed [16], 2) highly effective treatment is available that can significantly improve the quality of life and longevity of a patient [17–19], and 3) it is a notable example of the “bench to bedside” continuum in that knowledge of genetic mutations led to development of a new generation of drugs [20]. Because one of the facilitating faculty is diagnosed with FH, it also made it possible for us to have a “live” patient-centered learning activity. The FH-TBL emphasized FH physical stigmata (such as xanthomas), family history suggestive of FH, and the importance of early detection and early initiation of treatment for FH patients.

Scenarios of patient-centered cases are as follows (Supplementary Materials): Case 1 introduced a largely unappreciated sign of FH, Achilles tendon pain. Although Achilles tendon pain is experienced by nearly 50% of heterozygous FH patients, clinical awareness as a sign of FH is virtually non-existent [21]. Students were not told that this was a FH case. Case 2 was based on a de-identified real FH patient with a significant family history of coronary artery disease. Students were asked to: 1) draw a 3-generation pedigree and identify inheritance pattern of the family’s disease, 2) explain the clinical significance of xanthomas, 3) use the Dutch lipid clinic network score (Supplementary Materials) [16] to make a clinical diagnosis of the patients, 4) describe genetic testing strategies and how they would communicate the results to the patient, 5) assess disease risk for the patient’s future children, and 6) describe the phenotype of a homozygous FH patient. Case 3 focused on management of a preteen whose father was clinically diagnosed with FH. This case was facilitated by the FH patient faculty. Students explored: 1) genetic testing strategies to confirm clinical diagnosis of FH, 2) diagnostic strategies for children, and 3) management guidelines for children with FH by the professional medical societies [22].

### b. The Application of TBL-Case Learning to a Real-World Patient

A month after the FH-TBL, two participating students (authors RP and JV) volunteered for a medical mission to Honduras. The following is their testament of how they applied the FH-TBL learning experience to proposing homozygous FH as a differential diagnosis of a child presenting with physical features which can be observed in this condition (Fig. 1).

“In Honduras during a medical mission trip we saw a mother and her 5-year-old daughter for what seemed like a typical wellness check. The mother had a history of hypertension and hypercholesterolemia with no medication. When asked about her daughter the mother lifted the hem of the girl’s dress revealing raised, yellowish, papules on her knees. Upon further inspection, similar papules were found on her elbows and buttock. Remembering this particular exam finding from our FH-TBL, we consulted the supervising physician of the mission regarding the suspected finding of xanthomas. He told us they were probably keloids, but we requested confirmation. After a second opinion from a dermatologist, xanthomas were confirmed. The FH patient faculty stressed the importance of family history with a particular focus on hypercholesterolemia and heart disease, clinical manifestations of FH, and the importance of early treatment. Returning to family history, we discovered both mother and father had a history of hypercholesterolemia, leading us to suspect that the daughter might be a homozygous FH patient. We recommended a family physician to have her lipid levels examined as soon as possible, and also suggested that statins may be considered for her treatment plan should her LDL cholesterol levels be significantly elevated. Without the FH-TBL, we would not have been able to identify xanthomas, know how to elicit the family history, know the diagnostic tests to recommend, or the treatment to suggest.”

This real-world experience of students exemplifies that basic science content delivered in a clinically relevant format via active learning can be readily retained and applied to clinical practice. It has been reported that retention of basic science knowledge is correlated with its perceived relevance to clinical practice [24, 25]. Indeed, RP and JV state that the well-integrated learning experience with the FH patient faculty present made a deep impression which would remain retrievable even if the encounter were a few years later, which echoes the students’ reflections reported for a case-based learning event involving a real patient [26].

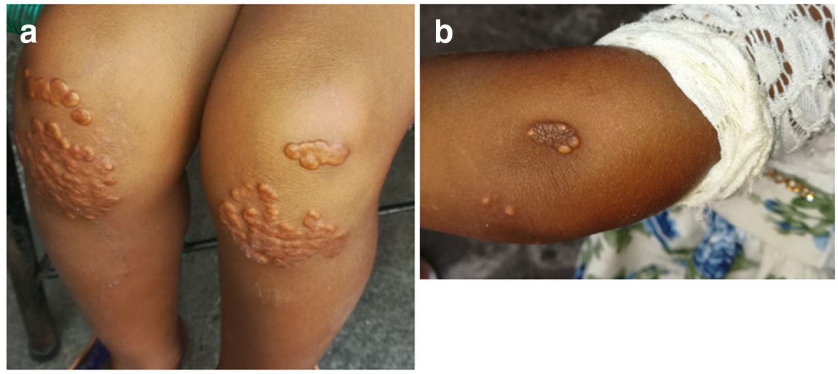


**Fig. 1** Putative xanthomas on the knee (**a**) and elbow (**b**) in a 5-year-old girl RP and JV encountered in Honduras. The child presented with putative tuberous xanthomas suggesting a hypercholesterolemic state. The most common genetic diseases associated with tuberous xanthomas are familial hypercholesterolemia (FH) [16] and familial combined hyperlipidemia (FCHL) [23]

In conclusion, our report further supports, albeit anecdotally, effectiveness of case-based TBL in bridging learning of basic science and its clinical application. Introducing a highly prevalent genetic disease using active learning allows for a robust cognitive connection cultivating clinical reasoning even in preclinical stage students.

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## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Ethical Approval** Not applicable.

**Statement of Informed Consent** Not applicable.

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