Emphasizing the Relevance of Biochemistry for Clinical Practice with a Novel Small Group Learning Activity

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Background

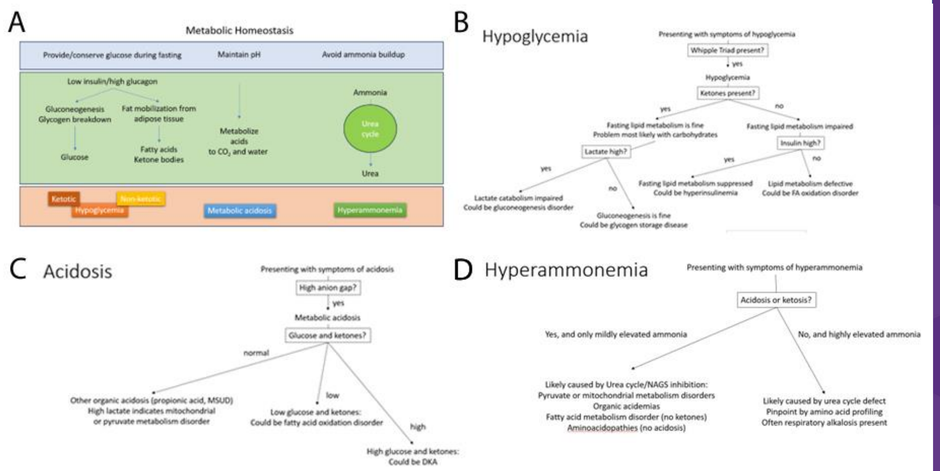
Health professions students often do not recognize the value of Biochemistry for the practice of medicine and more generally struggle to use foundational science principles for clinical reasoning [1]. We developed a 90-minute team-learning activity to emphasize the connection of Biochemistry with the clinical sciences. In this exercise ("Scientific Knowledge Integrated in Patient Presentations"; SKIPPs), students engage in a structured discussion of cases of children presenting with metabolic acidosis, hyperammonemia and hypoglycemia to explore the diagnostic strategy for inborn errors of metabolisms (IEM) [2]. Now in its third year, SKIPPS has shown to deliver significant learning outcomes not only of medical knowledge, but also in the domains of teamwork, clinical reasoning, and integration of foundational with clinical sciences.

Objective

Evaluate the effectiveness of a novel case-based team learning activity about the presentation of inborn errors of metabolism on teamwork, clinical reasoning, and the ability to integrate biochemistry and clinical sciences.

Format and Conceptual Framework

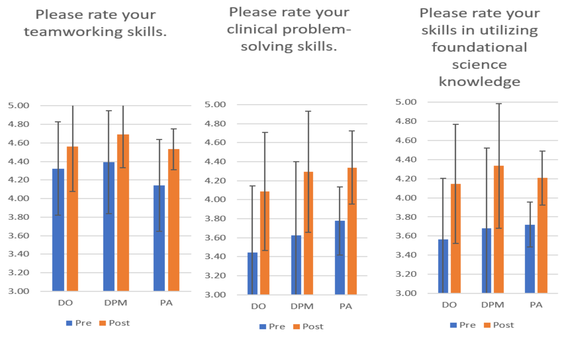
In the SKIPPs format, groups of 6-8 students from 5 health sciences programs (DO, DPM, PA, MBA, MSA) work through self-paced, interactive simulation slide presentations of encounters with children in metabolic crises resulting from IEMs (Figure 1). Students prepare for the session through guided self-study, assisted by handouts, quizzes and interactive tutorials. The clinical reasoning framework for the diagnosis of IEMs was developed according to Guerrero and co-workers [3]. In this framework, pediatric metabolic crises are categorized into hypoglycemia, hyperammonemia and metabolic acidosis, and the root cause is identified with a simple diagnostic strategy (Figure 2). The groups' case discussions were guided by basic science and clinical faculty facilitators, followed by short oral patient presentations and quiet study of relevant literature. In the final debriefing session, facilitators discussed the relevance of foundational science principles for the diagnosis and treatment of IEM.



120 minutes	Preparation: Independent review of Inborn Errors of Metabolism (Foundational Science course), formative quiz for readiness
30 minutes	Case 1 (group of 6): Patient presentation, Differential diagnoses, Diagnostic strategy, Discussion of lab values Case 2 (group of 6): Patient presentation, Differential diagnoses, Diagnostic strategy, Discussion of lab values Case 3 (group of 6): Patient presentation, Differential diagnoses, Diagnostic strategy, Discussion of lab values Case 4 (group of 6): Patient presentation, Differential diagnoses, Diagnostic strategy, Discussion of lab
20 minutes	Oral presentations to large group: Patient presentation, differential diagnoses, clinical reasoning strategies (1 student per group, 5 minutes per case)
20 minutes	Case 1 (group of 6): Literature study, Discussion of foundational science principles related to presentation and treatment Case 2 (group of 6): Literature study, Discussion of foundational science principles related to presentation and treatment Case 3 (group of 6): Literature study, Discussion of foundational science principles related to presentation and treatment Case 4 (group of 6): Literature study, Discussion of foundational science principles related to presentation and treatment
20 minutes	Large group debriefing: Integration of foundational and clinical sciences, practical aspects of IEM diagnosis and patient care

↑ Fig 1. Introduction (A) and clinical decision charts (B-D) for the three main metabolic crises resulting form IEM. An interactive branched-logic slideshow was programmed based on these diagrams and distributed to students.

← Fig 2 Organization of SKIPPs session.



← Fig 3. Student ratings by program in the domains of integration, clinical reasoning, and teamwork tasks (N=530; rating scale 1-5, all pre/post-differences significant at p=1.4E-6 or lower, pre/post effect sizes are all large for integration and clinical reasoning, small to large for teamwork).

Methods – Assessment of Learning Outcomes

SKIPPs outcomes were measured with the regularly scheduled course exam and through anonymous pre/post-surveys of students and facilitators. The surveys assessed student confidence and performance in the areas of teamwork, clinical reasoning and the ability to integrate basic and clinical sciences with 8 questions using a 5-point sliding scale. The resulting data showed non-normal distribution by Shapiro-Wilkes Test and were subsequently analyzed with non-parametric tests for significance (Mann-Witney U-test). Effect sizes were calculated as Cohen's d. Students were also encouraged to leave free-text comments, which were analyzed with an emerging-theme analysis protocol.

Results and Discussion

The pre/post comparison of student self-assessments show significant improvement of clinical reasoning and teamworking skills, accompanied by an increase in ability to integrate basic science concepts and clinical observations (Fig. 3). All categories and all cohorts showed significant gains, with the strongest effects occurring in clinical reasoning. All groups passed the facilitator evaluation (>3.5/5 on a similar rubric) and average scores on SKIPPs MCQ were 5.1% above the overall average. Emerging theme analysis of free text responses (N=93) were overwhelmingly positive (85%). The most common themes were "great teamwork experience", "need more time to prepare" and "welcome opportunity to apply classroom knowledge to clinical scenarios".

Conclusions

We found that the discussion of strategies for the diagnosis and treatment of inborn errors of metabolism is an excellent tool for teaching the basic science and clinical aspects of metabolism. The presentations of hypoglycemia, hyperammonemia and metabolic acidosis cover deficiencies of all major areas of metabolism (carbohydrates, lipid, and amino acid catabolism), and the diagnostic flowcharts for these presentations provide a simple tool for the interpretation of clinical biochemistry data and the review of pathway functions. We further conclude that the interactive and deliberately structured SKIPPs format is an effective tool for developing clinical reasoning and teamworking skills in mixed groups of early health professions students. Finally, the organization of SKIPPs and the use of self-guided presentations allowed an effective deployment of personnel resources, requiring just 40 facilitator hours for 300 students.

References

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2. Schmidt, M.; Pinney, B.; Canby, C.; Vargus, A.; Pille, M. An early-curricular team learning activity to foster integration of biochemical concepts and clinical sciences in undergraduate medical education. Biochemistry and Molecular Biology Education 2024, n/a, doi:https://doi.org/10.1002/bmb.21821.
3. Guerrero, R.B.; Salazar, D.; Tanpaiboon, P. Laboratory diagnostic approaches in metabolic disorders. Ann Transl Med 2018, 6, 470, doi:10.21037/atm.2018.11.05.