Online Team-Based Learning in Teaching Hyponatremia Among Medical Clerks of the University of Santo Tomas Faculty of Medicine and Surgery, Philippines

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ABSTRACT

Objectives: To determine if online team-based learning (TBL) is effective in improving knowledge outcomes and confidence about hyponatremia in its clinical recognition, classification, diagnostic work up, and management among fourth year medical students

Study Design: A quantitative evaluative design.

Population and Setting: Fourth year medical students (medical clerks) rotating in the Department of Medicine, Faculty of Medicine and Surgery, University of Santo Tomas, Manila, Philippines from July to December 2020.

Methodology: A modified TBL workshop is adopted in teaching fourth year medical clerks about hyponatremia. The TBL session was held with a group of medical clerks weekly from July to December 2020. As a pre-workshop preparation, the medical clerks were assigned to read ahead of time the clinical practice guidelines on the diagnosis and treatment of hyponatremia developed by the European Renal Best Practice. After reading it, they were asked to answer an Individual Readiness Assessment Test (IRAT) composed of 20 case-based multiple-choice questions (MCQ). The group was thereafter divided into 4 subgroups and asked to discuss the same MCQ-based exam and present it as a Team Readiness Assessment Test (TRAT). As each subgroup presented their IRAT, the facilitator discussed the underlying concepts for each question and its application in actual cases of hyponatremia. The facilitator then summarized the learning outcomes at the end of the TBL workshop. For team application (TAPP), the students created a concept map and formulated admitting orders. The medical clerks were then surveyed on their confidence in hyponatremia diagnosis and management during pre-TBL workshop, after IRAT, after TRAT, and after discussion with the facilitator.

Statistical Design: Descriptive statistics were used to summarize the study variables and included the mean, standard deviation, frequency, and percentage. Within-group comparisons of different outcomes across the different timeframes were conducted using one-way multivariate analysis of variance (one-way MANOVA). Cognizant that the study has multiple outcomes or dependent variables which were compared at four different timeframes, multivariate analysis was utilized to minimize the inflation of family-wise errors (FWE).

Results: Comparative analysis indicated that the mean readiness scores of the respondents after TRAT was significantly higher (t=–91.61, p=0.001) compared to the mean readiness scores after IRAT. Comparative analysis using paired t-test indicated that the mean confidence scores of the respondents in the recognition, diagnosis, and treatment of

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hyponatremia were significantly higher among the respondents after the IRAT (t=–24.26, p=0.001), TRAT (t=–34.58, p=0.001), and facilitator discussion (t=–42.72, p=0.001) approaches compared to the mean pre-TBL confidence score. The mean knowledge score of the respondents on the creation of a concept map and the formulation of admission orders of patients with hyponatremia was 25.54±1.98 (95% CI 25.26-25.82).

Conclusion: Findings of this study are not to be interpreted as demonstrating a causal relationship. Furthermore, the results are only hypothesis-generating at best. The study showed that online TBL has the potential to be an effective method in improving knowledge outcomes and confidence about hyponatremia in its clinical recognition, classification, diagnostic work-up, and management among fourth year medical students. As a preliminary evaluation of TBL, further studies can be conducted to determine its effectiveness as a teaching modality in the medical curricula in comparison to the traditional method before being adopted as a teaching-learning activity.

Key words: team-based learning, online learning, COVID-19, hyponatremia, medical education

INTRODUCTION

Fluid and electrolyte disturbances are very common in the hospital setting and can cause significant morbidity. Medical clerks being the frontliners must be able to recognize these problems early enough to initiate appropriate interventions to prevent prolonged hospitalization and mortality. They must be able to identify the etiology of the problem, understand the appropriate diagnostic approach, determine the formulas needed to resolve the problem, apply the formulas to the case, formulate the correct intravenous therapy, and anticipate possible complications of therapy. Moreover, fluid and electrolyte disturbances remain to be one of the hardest topics to understand, diagnose, and manage for majority of physicians, more so, for medical clerks. The traditional method of teaching this topic that is teacher-centric such as lectures, chalk-and-talk method still cannot deliver the needed in-depth understanding of the said topic. Teaching hyponatremia in a traditional face-to-face setting is already quite a challenge for the facilitators. All the more, during the COVID-19 pandemic and lockdown, online learning as an alternative method of teaching hyponatremia would really pose an additional difficulty both to the facilitators and students. Thus, there is a need for a learning and teaching activity that can address the complexity of the topic. The team-based-learning (TBL) approach has potential to address such concerns. Online TBL is an alternative learning teaching strategy that can be adopted in teaching fluid and electrolyte disturbances such as hyponatremia. The pre-class preparation in TBL would facilitate the students' accountability for their own learning. Its collaborative design would enhance teamwork and authentic exercises would expose them to real-world hospital scenarios.

Dr. Larry Michaelsen originally developed TBL for business schools, but has been adopted by many medical schools as a structured form of learning. [1-5] This type of learning has been applied to the different levels of learners, settings, as well as content areas. [3] It has been applied in multiple disciplines in the undergraduate medical curricula, more so in pre-clinical years (basic sciences) than the clinical years. Burgess et al. in 2014 did a systematic review on the impact of TBL programs in 20 medical schools and reported that TBL had a positive impact on the learning experience of students. [3]

Team-based learning is a structured learning and instructional strategy that can be applied both in a small and large group of students (more than 100) that have been divided into small groups wherein conceptual knowledge can be applied initially as an individual work and later on collaborate with team members, after which, the facilitator would provide immediate feedback. [1] As a learning tool, students are actively engaged from start to finish of the activity, either individually or as part of the team. A large number of faculty is not necessary even with a large number of students. Thus, TBL programs would serve as a resource-saving measure for the medical school as well. In order to preserve the fidelity of TBL as an effective learning strategy and in order for other medical schools to replicate and assess outcomes, a standardized framework was formulated. In its purest form, TBL has seven core design elements, namely: (a) team formation, (b) readiness assurance, (c) immediate feedback, (d) sequencing of in-class problem solving, (e) the four S's [must have a significant problem, same problem

for all teams to solve, all teams must have a specific choice in their answer, and simultaneous reporting for all the groups], (f) incentive structure, and (g) peer review). [3,6]

A standard TBL program must have the following three phases: (a) advanced preparation, (b) readiness assurance, and (c) application task. A TBL program is considered modified if the program has one or two phases missing or significantly modified from the classic program. [4]

An ideal team size would be five to seven students since this number would be small enough to boost team dynamics but large enough to have knowledge sources and discussion. [2] For the readiness assurance part, both individually and as a team, the assigned reading materials are the source of the individual and team test questions reflecting everybody's readiness, motivation, and accountability for the activity. [7,8]

Immediate feedback is provided by the faculty by discussing the test questions and emphasizing the concepts used, leading to knowledge understanding, eventual acquisition, and retention. [2,9]

Sequencing of in-class problem-solving is considered the heart of TBL since this is the time the students as a team would apply their newly gained knowledge in an authentic scenario. Through the collaborative effort of the group, they should be able to defend their plans and choices from their own point of view. [1] The incentive structure of the TBL program must be well-defined for the students from the very start. A grading system with well-defined parameters is crucial to provide motivation for both individual inputs and effective team dynamics. Assigned weighted grades should be given for individual readiness assessment test (IRAT), team readiness assessment test (TRAT), team application of the problem (TAPP), and peer review. Peer review would substantiate student accountability. Giving peer feedback would cultivate the students' competencies in objectively assessing a colleague's contribution to the team, hopefully guiding them on how to practice professionalism, more so as an aid to learning. [10,11]

This study is interested to know the effectivity of online TBL in teaching hyponatremia among medical clerks. in terms of clinical recognition, disease classification, diagnostic work-up, and management. Likewise , the effect of TBL on the confidence of the medical clerks in hyponatremia diagnosis and management at predetermined timeframes (i.e., pre-TBL workshop, post-IRAT, post-TRAT, and post-discussion)

THEORETICAL FRAMEWORK

Team-based-learning follows on the principle of constructivist learning theory, both cognitive constructivism by Jean Piaget and social constructivism by Lev Vygotsky. [12]

Piaget's cognitive constructivism is founded on the principle that learning is an active rather than a passive process and it should be whole, authentic and real to be effective. Vygotsky's social constructivism is based on the principle that social interaction plays a very important role in the cognitive development. It involves the More Knowledgeable Other (MKO), which refers to anyone who has better understanding or higher ability level than the learner, i.e., normally thought of as being a teacher, trainer, or older adult, but may also be peers, a younger person, or even computers. In this case, the MKO is the facilitator. Vygotsky's Zone of Proximal Development (ZPD), refers to the area where the most sensitive instruction or guidance should be given, allowing the students to develop skills that they will then use on their own that would later result in developing their higher mental functions. In the case of TBL, it is the immediate feedback part wherein the facilitator discusses the underlying concepts for each question, as well as the application exercises (i.e., TAPP) where the students create concept maps and formulate admitting orders that serve as the ZPD. [12-15]

The concept of "collective scaffolding" is very important in TBL. Inside the class, each member may contribute only partially in completing the task. But this partial knowledge from each member combines together under the teacher's guidance to achieve complete understanding and accomplishment of the task. The idea of collective scaffolding grounded in Vygotskian thinking suggests that the group ZPD is larger than the individual ZPD. This means that what a group of trainees can do together is much beyond what each individual can do alone. The model of involvement in a development process suggests that trainees acquire different skills and knowledge through collaboration with peers. From Vygotskian perspective, the group members can provide collective scaffold for each other to remedy their instructional problems. They engage in

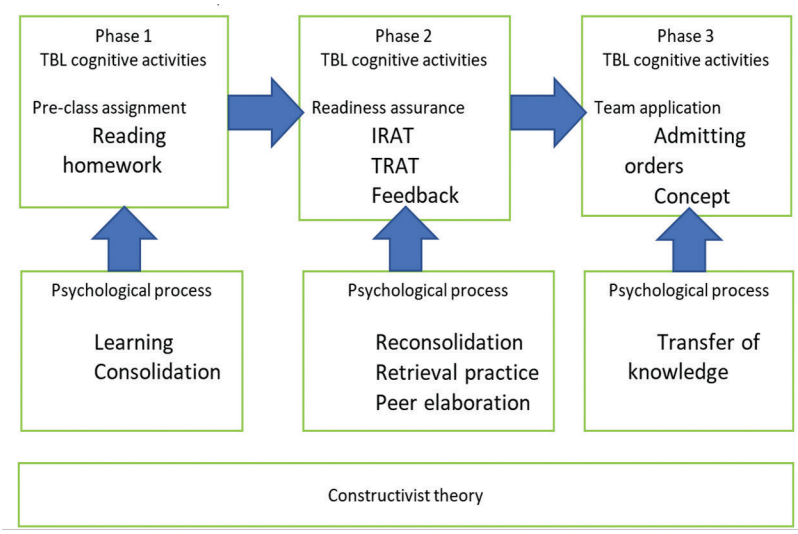

Figure 1. Different phases of TBL cognitive activities link to the constructivist theory and psychological foundation

conducting collaborative research and discussions. Later on, the process of internalization will occur. During the repeated engagement of the MKO and the learner where scaffolding is always provided, there is transformation of social behavior from the inter-mental to the intra-mental state where the real process of internalization occurs, leading to the learner no longer needing scaffolding. It is during internalization wherein the learner upgrades to a higher level or even highest level of learning regarding certain knowledge or skill like an expert. [16]

The three phases of memory formation, namely learning, consolidation, and reconsolidation of knowledge, transpire during the TBL sessions. Schmidt et al. suggested that the psychological foundation for TBL involves the knowledge reconsolidation hypothesis. This hypothesis is based on the four psychological mechanisms (i.e., retrieval practice, peer elaboration, feedback, and transfer of learning) that are individually correlated with the different phases of TBL. The pre-class preparation involves learning new materials resulting in initial consolidation of newly learned knowledge after sleeping. As they go to the scheduled classes, the class activities will cause reconsolidation of previously learned or consolidated knowledge. Knowledge reconsolidation saves, strengthens and refines the students' previous knowledge that has already been saved as long-term memory. During the IRAT, the retrieval of consolidated knowledge happens. The TRAT facilitates peer elaboration wherein team discussion happens. TRAT is the phase of TBL that provides immediate feedback to their IRAT answers, as well as a different perspective of the difficult concepts encountered. All unresolved questions serve as a burning question wherein the facilitator can give elaborate feedback. The TAPP phase enables the students to apply what they have learned to other situations or contexts, thus transfer of learning would occur. [17]

CONCEPTUAL PARADIGM

Research Setting

Department of Medicine, Faculty of Medicine and Surgery, University of Santo Tomas, Manila, Philippines

RESEARCH APPROACH

Study Design

Quantitative, evaluative design

Study Population

The study population included fourth year medical students (medical clerks) from Groups 1 to 12 of the University of Santo Tomas Faculty of Medicine and Surgery Batch 2021 rotating in the Department of Medicine.

Sample size computation for one-way MANOVA was conducted using GPower version 3.1.9.4. For a moderate effect size *f* of 0.25, a minimum power of 80%, and a significance level of 5% (two-tailed), a sample size of 48 respondents was computed.

Research Instrument

Clinical practice guidelines on the diagnosis and treatment of hyponatremia developed by the European Renal Best Practice was used as an assigned reading material prior to the TBL workshop proper. Then, 20 case-based multiple choice questions (MCQ) were used as the Individual Readiness Assessment Test (IRAT) on the diagnosis and management of hyponatremia and also as the Team Readiness Assessment Test (TRAT). A 10-point Likert scale survey on their confidence about hyponatremia diagnosis and management during pre TBL workshop, after IRAT, after TRAT, and after discussion with the facilitator was used.

METHODOLOGY

A modified TBL workshop was adopted in teaching fourth year medical clerks about hyponatremia. The TBL session was held with a group of medical clerks weekly. As pre-workshop preparation, the medical clerks were assigned to read ahead of time the clinical practice guidelines on the diagnosis and treatment of hyponatremia developed by the European Renal Best Practice. After reading it, they were asked to answer an IRAT composed of 20 case-based multiple choice questions. The group was thereafter divided into 4 subgroups and asked to discuss the same MCQ-based exam and presented it as a TRAT. As each subgroup presented their IRAT, the facilitator discussed the underlying concepts for each question and its application in actual cases of hyponatremia. The facilitator then summarized the learning outcomes at the end of the TBL workshop. For TAPP, the students created a concept map and formulated admitting orders. The medical clerks were then surveyed on their confidence in hyponatremia diagnosis and management during pre TBL workshop, after IRAT, after TRAT and after discussion with the facilitator.

STATISTICAL DESIGN

Statistical analyses were performed using STATA MP Statistical Software, version 13, College Station, TX: StataCorp LP. A *p*-value ≤0.05 was considered statistically significant. Descriptive statistics were used to summarize the study variables and included mean, standard deviation, frequency, and percentage. Within-group comparisons of different outcomes across the different timeframes wase conducted using one-way multivariate analysis of variance (one-way MANOVA) [18]. Cognizant that the study has multiple outcomes or dependent variables which were compared at four different timeframes, multivariate analysis was utilized to minimize the inflation of family-wise errors, thus, decreasing the likelihood of type I (false positive) errors. [18]

RESULTS

Table 1 illustrates the within-group comparison using paired *t*-test among the respondents using the IRAT and TRAT methods. As presented, the mean readiness score of those who underwent the IRAT was 28.69 (SD=1.67), while those who had the TRAT had a mean score of 39.58 (SD=0.76) with a mean difference of –10.89 (SD=1.64). Comparative analysis indicated that the mean readiness scores of the respondents after TRAT was significantly higher (*t*=–91.61, *p*=0.001) compared to the mean readiness scores after IRAT.

The within-group comparison of the mean confidence scores before the TBL and after the TBL (i.e., IRAT, TRAT, and facilitator discussion) are presented in Table 2. It can be noted that the mean

Table 1 *Within-Group Comparison of Readiness Scores using IRAT and TRAT among the Respondents (N = 191)*

	Mean (SD)		Mean Difference	t-value	*p*-value (Two-Tailed)
	IRAT Scores (N = 191)	TRAT (N = 191)			
Readiness Score	28.69 (1.67)	39.58 (0.76)	–10.89 (1.64)	–91.61	0.001

*Significant at 0.05
†Significant at 0.01

Table 2 *Within-Group Comparison of Confidence Scores before the TBL Approach and after the IRAT, TRAT, and Facilitator Discussion Methods among the Respondents (N = 191)*

	Mean (SD)				Pairwise Comparisons[a]		
	Pre-TBL	Post-TBL			Pre-TBL vs. Post-TBL (IRAT)	Pre-TBL vs. Post-TBL (TRAT)	Pre-TBL vs. Post-TBL (Facilitator Discussion)
		IRAT	TRAT	Facilitator Discussion			
Confidence Score	3.97 (1.66)	6.41 (1.54)	7.50 (1.20)	8.77 (0.90)	–24.26 (0.001)	–34.58 (0.001)	–42.72 (0.001)

[a]*Data* are presented as *t*-value (*p*-value)
[*]*Significant* at 0.05
[†]*Significant* at 0.01

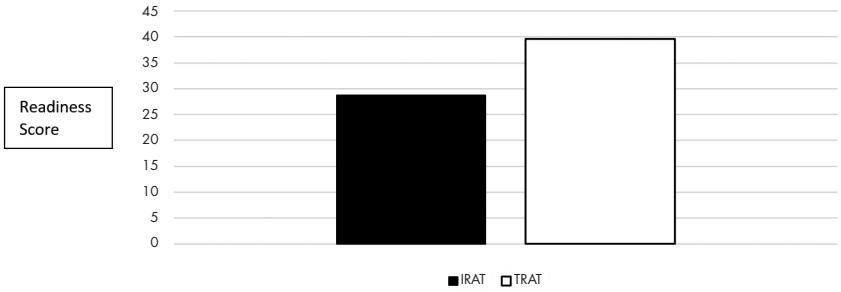

Figure 2. Readiness Score using IRAT and TRAT

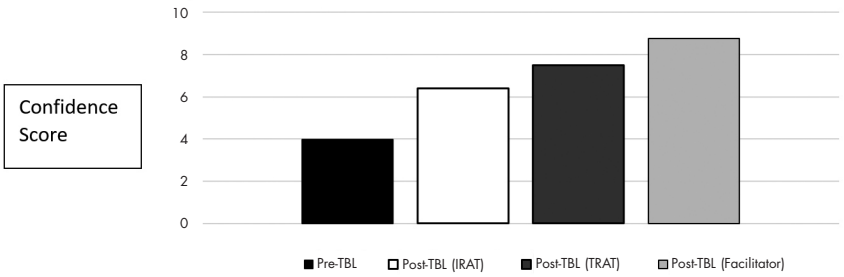

Figure 3. Confidence Scores Pre-TBL and Post-TBL

confidence score of the respondents in the recognition, diagnosis, and treatment of hyponatremia before the TBL approach was 3.97 (SD=1.66). In contrast, the mean confidence scores of the respondents after the different TBL approaches – IRAT, TRAT, and facilitator discussion approaches – were 6.41 (SD=1.54), 7.50 (SD=1.20), and 8.77 (SD=0.90), respectively. Comparative analysis using paired *t*-test indicated that the mean confidence scores were significantly higher among the respondents after the IRAT (t=–24.26, p=0.001), TRAT (t=–34.58, p=0.001), and facilitator discussion (t=–42.72, p=0.001) approaches compared to the mean pre-TBL confidence score.

The mean knowledge score of the respondents on the concept map creation and admission of patients with hyponatremia was 25.54±1.98 (95% CI 25.26-25.82).

DISCUSSION

Teaching and learning activities (TLA) ideally must always be engaging and must result in the realization of the intended learning outcomes. The active participation of each student from beginning to end as well as the peer involvement in the active learning process can be realized in the adoption of TBL as a TLA. This study has shown its effectiveness in terms of mean readiness and confidence scores of the medical clerks that were higher after the TRAT compared to IRAT. In this case, it can be seen that the new knowledge that has been gained

by the medical clerks on individual reading was strengthened after peer collaboration and immediate feedback by the facilitator. Peer discussion definitely opens an avenue of different perspectives on a particular aspect of the new knowledge gained, thus strengthening the understanding of such knowledge. Haidet et al. recognized the fact that TBL could be applied in many aspects of medical education, such as from basic sciences to solving clinical problems in authentic life situations. They have suggested a conceptual model and a set of guidelines to follow in using TBL for standardization and reporting purposes. [6] This suggestion may not be easy to carry out in certain situations such as having time constraints and will depend on the targeted learning outcomes as assessed by the involved facilitator. Thus, TBL in its purest form may not be realized at all times.

The advantage of adopting TBL was realized during the course of this research activity. TBL definitely eliminated the time consuming and boring teacher-centered lecture on hyponatremia. Early identification of an appropriate reading material on hyponatremia (2014 European Clinical Practice Guidelines on Hyponatremia) anchored the TBL activity. [19] The independent pre-activity reading preparation 2 to 3 days before jumpstarted the TBL activity. This asynchronous activity reinforced self-directed learning. Likewise, it proves that in this kind of TLA, minimal instruction supervision from the facilitator is demanded, thus, independent and critical thinking are developed. However, it was noted that most of the time, majority of the medical clerks were honest enough to confirm that they were not able to read in full the assigned reading material as expected of them. Most of them just focused on the part where the answers for the IRAT questions can be extracted. Many factors can be considered at this point. One major factor would be the online fatigue these medical clerks have been experiencing since it has been more than a year since the COVID-19 pandemic started and these medical clerks were confined to their houses for a long time. The peer discussion and the facilitator feedback compensated for all these shortcomings and resulted in a much clearer concept on the problem and treatment of hyponatremia.

In a study by Vasan et al. in 2008, they compared TBL and traditional lectures in delivering medical gross anatomy and embryology subjects. They documented that students utilizing the TBL approach performed better in examinations compared to the group of students exposed to the traditional lecture-based teaching. [20] These students gained independence, actively participated in TLAs and became team players. This type of study would be ideal to adopt in the local setting wherein there will be a head-on comparison between the TBL and the traditional lecture type of topic delivery.

Aside from pre-activity readiness and team interaction, application tasks of the TBL activity is the most important aspect of this TLA. The creation of the concept map on the recognition, diagnosis, and management of hyponatremia truly reflect the consolidation of knowledge about hyponatremia. The different concept maps created by the different groups showcased the diversity of thinking these medical clerks have about hyponatremia despite having read the same reading materials. Nevertheless, no matter how simple or complicated the concept maps created, the structured thinking about hyponatremia was projected in all which for sure cannot be accomplished by a traditional teacher-centered type of TLA. The formulation of the admitting orders in a patient with hyponatremia served as another application task of the TBL activity that makes this TLA authentic in nature. The transfer of learning is very evident as the admitting orders defined the expected diagnostic and therapeutic plans in patients with hyponatremia. Thus, the ability of the medical clerks to create a well-constructed concept map and to formulate appropriate admitting orders in patients with hyponatremia reflected that the expected learning outcome of TBL was realized.

This study has methodological limitations. As an evaluation of the TBL approach and with the COVID-19 pandemic, a comparative analysis with a control group was not feasible. Hence, the true effects of TBL were not compared with the traditional teaching method which may lead to overestimations. With this, the current results must be analyzed and interpretated with caution. In addition, as an evaluative study, the findings of this study may only reflect the potential of TBL in improving teaching of hyponatremia but needs to be verified with the prevailing or traditional method of teaching in medical institutions.

CONCLUSION

Findings of this study are not to be interpreted as demonstrating a causal relationship. Furthermore, the results are only hypothesis generating at best. The study showed that online TBL has the potential to be an effective method for teaching hyponatremia among medical clerks. It improves knowledge outcomes and confidence about hyponatremia in its clinical recognition, classification, diagnostic work-up, and management pre-TBL workshop, post-IRAT, post-TRAT, and post-discussion. As a preliminary evaluation of TBL, further studies can be conducted to determine its effectiveness as a teaching modality in the medical curricula in comparison to the traditional method before being adopted as a teaching-learning activity.

Declaration of Competing Interests: None

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APPENDIX A. CASE AND IRAT/TRAT TEST QUESTIONS

HYPONATREMIA WORKSHOP: IRAT: CASE:

55 year old bank executive female diabetic, hypertensive admitted due to dyspnea. She has history of 2 previous AMI and heavy smoker. She has easy fatigability , 2 pillow orthopnea. On high back rest, in distress, no cyanosis . BP 160/90, PR 110 RR 25 T 37.4 Wt. 50 kg. JVP 5cm at 45 degree Use of accessory muscles of respiration, bilateral crackles on T7. Apex displaced to 6th ICS AAL With s3 gallop. With bipedal edema. CBC normal .Creatinine 0.8 mg/dl.Na 115 mmol/L. K 3.8 mmol/L FBS -10 mmol/L BUN – 7 mmol/L12 EKG NSR, poor r wave progression, old inferior wall mi

1. What is the main problem of the patient ?
2. What is the most likely temporal classification of hyponatremia?

A. acute
B. chronic

3. What is the biochemical severity level of hyponatremia?

A. mild
B. moderate
C. severe

4. Classify the degree of patient's manifestation of symptoms secondary to hyponatremia

A. Manifesting severe symptoms
B. Manifesting moderately severe symptoms
C. Without severe or moderately severe symptoms

5. What is the patient's extracellular volume status? rationalize

A. Decreased
B. Normal
C. Increased

6. What will be the computed serum osmolality?

A. 235
B. 247
C. 266
D. 285

7. Compute for the corrected level of serum Na with the present serum glucose result to rule out hyperglycemic hyponatremia.

Na 115 mmol/L
FBS 10 mmol/l

A. 115
B. 115.8
C. 116
D. 117

8. State the complete description of patient's hyponatremia

A. Chronic Moderately Sx Euvolemic Profound Hypotonic Hyponatremia
B. Chronic Severely Sx Hypovolemic Moderate Hypotonic Hyponatremia
C. Chronic Asx Hypervolemic Mild Hypotonic Hyponatremia
D. Chronic Moderately Sx Euvolemic Moderate Hypotonic Hyponatremia
E. Chronic Severely Sx Hypervolemic Profound Hypotonic Hyponatremia

9. Which parameters to be used for differentiating causes of hypotonic hyponatremia?

A. Urine osmolality
B. Urine Na
C. Vasopressin level

10. Our patient has chronic severely symptomatic, what is the management needed in the first hour?

State the type of IV fluid, volume and infusion time.

A. 150 ml 3% hypertonic over 20 min
B. 150 ml of 0.9% saline in 20 min
C. 150 ml 0.45 % saline over 20 min
D. 150 ml of 0.3% saline in 20 min

11. Our patient has chronic moderately symptomatic hyponatremia, what is the immediate management needed ?

State the type of IV fluid, volume and infusion time.

A. 150 ml 3% hypertonic over 20 min
B. 150 ml of 0.9% saline in 20 min
C. 150 ml 0.45 % saline over 20 min
D. 150 ml of 0.3% saline in 20 min

12. Our patient has chronic moderately symptomatic hyponatremia, what is the target increase in the serum Na in 24 hours?

A. 5 mmol/l
B. 8 mmol/l
C. 10mmol/l
D. 12 mmol/l

13. If our patient has acute hyponatremia without severely or moderately symptomatic hyponatremia, what is the management needed ?

State the type of IV fluid, volume and infusion time.

A. 150 ml 3% hypertonic over 20 min
B. 150 ml of 0.9% saline in 20 min
C. 150 ml 0.45 % saline over 20 min
D. 150 ml of 0.3% saline in 20 min

14. Our patient has chronic hyponatremia without symptoms, what is the recommended maximum increase in serum sodium concentration of during the first 24 h and during every 24 h thereafter?

A. 5 mmol/l; 7 mmol/l
B. 8 mmol/l; 8 mmol/l
C. 10mmol/l; 8 mmol/l
D. 12 mmol/l; 10 mmol/l

15. Chronic hyponatraemia without severe or moderately severe symptoms: Patients with expanded extracellular fluid

Female 50 kg Na 115

What is the computed total body water?

A. 15
B. 20
C. 25
D. 30

16. What is the target serum Na correction for the day?

A. 6
B. 10
C. 12
D. 14

17. What is the computed Na deficit?

A. 150
B. 250
C. 300
D. 350

18. What type of IV fluid will be used in this case?

A. D5Water
B. 0.45% NaCl
C. 0.9% NaCl
D. 3.0% NaCl

19. How much of the chosen IV fluid would you need to achieve your computed deficit? (approximately)

A. 100 cc
B. 200 cc
C. 300 cc
D. 400 cc

20. What would be the rate of your IV fluid? approximately

A. 5
B. 10
C. 15
D. 20

APPENDIX B. CONCEPT MAP GRADING RUBRICS* 20 POINTS

CRITERIA	WEIGHT	MAXIMUM	MPL	POINTS				POINTS
1. Form and Appearance	5%	5	3	Full of spelling errors, very hard to read: 0-2 points	Some spelling errors, moderately organized 3-4 points	Neat, well-organized, no spelling errors: 5 points		
2. Accuracy	5%	5	3	Many inaccurate concepts: 0-2 points	A few inaccurate concepts: 3-4 points	All concepts are accurate and factual: 5 points		
3. Completeness	10%	10	6	Limited number of concepts and relationships used: 0-2 points	Included mostly minor concepts but missed important major concepts and relationships3-4 points	Included most of the major important concepts and relationships: 5-7 points	Completed the major important concepts and relationships: 8-10 points	
4. Significance and Meaningful Connection	10%	10	6	No meaningful connections between concepts: 0-2 points	A few meaningful connections made: 3--4 points	Most connections were significant and meaningful: 5-7 points	All connections are logical, significant and meaningful: 8-10 points	
*Adapted from Mueller's Classroom Concept Map Rubric							TOTAL POINTS	

APPENDIX C. ADMITTING ORDERS GRADING RUBRICS 10 POINTS

CRITERIA	WEIGHT	MAXIMUM	MPL	POINTS				POINTS
Correctness of prioritization, clearness and sequence of orders	5%	5	3	All or Majority of orders are not in order of priority, vague and not in sequence 0-1 points	Some orders are not in order of priority, not all clear and in acceptable sequence 2-3 points	All or All or majority of orders are in order of priority , clear and in sequence 4-5 points		
Completeness	5%	5	3	Limited number of diagnostic and therapeutic orders : 0-2 points	Included mostly the important diagnostic and therapeutic orders 3 points	Included most of the major important diagnostic and therapeutic orders 4 points	Complete and included the important major diagnostic and therapeutic orders 5 points	
							TOTAL POINTS	