

## Effect of a Medical Formation Curriculum on the Development of Clinical Competencies to Identify and Manage CKD

*Efecto de un Programa de Formación Médica en el Desarrollo de Competencias Clínicas para Identificar y Manejar la ERC*

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### ABSTRACT

**Introduction:** Chronic kidney disease is a worldwide epidemic and represents one of the most important challenges for the health personal; because of this, the importance of generating competent human resources is crucial to the correct treatment and prevention of this disease. **Objective:** To measure the effect of a medical formation curriculum on the development of clinical competencies to identify and manage chronic kidney disease.

**Methods:** A quasi-experimental study was carried out at the Guadalajara LAMAR University Campus Vallarta in the first scholar semester of 2019 (2019A cycle). With a sample of 133 medical students, which 18 were from second semester (G1), 31 from fourth semester (G2), and 84 medical interns (G3); additionally, we included 22 college students with no medical formation to form the fixed group (G0). The Instrument used was a Spanish-language scale that evaluated the knowledge on chronic kidney disease, whose total sum allows the identification of the clinical competencies. The analysis was made by means of non-parametric inferential statistics (*p-Value* of  $\leq 0.05$ ).

**Results:** The clinical competency was higher in those who were exposed to the medical formation program: G1 attained 38.8% of competence, G2 achieved 35.5%, and G3 had 61.91% of competence expectations. Meanwhile, G0 achieved only 18.1%

of competence. **Conclusion:** The evaluation of the curriculum, during the 2019A cycle, showed a gradual growth of professional competences in chronological form, which gets higher when the theoretical knowledge is combined with the clinical practice.

**Keywords:** clinical competence; chronic kidney disease; curriculum; medical education

### RESUMEN

**Introducción:** La enfermedad renal crónica es una epidemia mundial y representa uno de los mayores desafíos para el personal de salud; por este motivo, es crucial generar recursos humanos competentes para el tratamiento correcto y la prevención de esta enfermedad. **Objetivo:** Medir el efecto de un plan de estudios de medicina sobre el desarrollo de competencias clínicas para identificar y tratar la enfermedad renal crónica.

**Material y métodos:** Se desarrolló un estudio cuasiexperimental en la Universidad LAMAR de Guadalajara, campus Vallarta, durante el primer semestre de 2019 (ciclo 2019A). Participaron 133 estudiantes de medicina: 18 de ellos del segundo semestre (G1), 31 del cuarto semestre (G2) y 84 residentes (G3); además, se incluyó a 22 alumnos universitarios sin formación en medicina para establecer el grupo control (G0). El instrumento utilizado fue una escala en idioma español que evaluó los conocimientos sobre enfermedad

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renal crónica, cuya suma total permite identificar las competencias clínicas. El análisis se realizó mediante estadística no paramétrica (valor  $p \leq 0,05$ ). **Resultados:** La competencia clínica fue mayor en los que estuvieron expuestos al programa de formación médica: G1 alcanzó el 38,8% de competencia; G2, 35,5%, y G3, 61,91%. Mientras tanto, G0 alcanzó solo el 18,1% de competencia. **Conclusión:** La evaluación del plan de estudios durante el ciclo 2019A mostró un crecimiento paulatino de las competencias profesionales en orden cronológico, que se eleva cuando se combinan los conocimientos teóricos con la práctica clínica.

**Palabras Clave:** competencia clínica; enfermedad renal crónica; plan de estudios; educación médica

## INTRODUCTION

Chronic kidney disease (CKD) is defined as a decrease in the renal function; expressed by a glomerular filtration rate (GFR) lower than 60 ml/min/1.73m<sup>2</sup>, or as the presence of renal damage for at least three months, which includes histological abnormalities, albuminuria-proteinuria, and alterations of the urinary sediment or in imaging tests.<sup>(1)</sup> According to the Pan American Health Organization (PAHO) about 10% of the world's population suffers from CKD,<sup>(2)</sup> with mortality rates that have increased from 11.18% in 1990 to 16.75% per 100 thousand inhabitants since 2015, in patients of both sexes and ages.<sup>(3)</sup>

Patients diagnosed with CKD present a series of changes in their lives, to the extent of limiting their daily activities due to the need of therapeutic adherence, which affects their proper development and increases the risk for the development of psychological disorders.<sup>(4)</sup> However, although CKD may be preventable, its early stages are asymptomatic, which means that its early diagnosis is difficult and that the only remaining treatment are the dialysis (peritoneal or hemodialysis), or the renal transplantation, both of them overly expensive and invasive.<sup>(5)</sup>

Despite this last situation, there is a significant lack of resources in the public health institutions to attend the patient's needs with CKD; not only in terms of real estate, but also of capable human resources that can properly identify, diagnose, treat and prevent this disease.<sup>(5)</sup> Because

of this, the importance of generating efficient health professionals, with an appropriate clinical competence, is crucial for the correct management of the CKD and the prevention of its possible secondary complications.<sup>(6)</sup>

One of the best ways to achieve this objective is to recognize if the human resources are being produced adequately, either by evaluating the formation of the undergraduate students, or by identifying if a medical formation curriculum is having the correct effect on their level of competence. Conceptually, the clinical competence of a medical student can be defined as a dynamic construct, which integrates abilities such as knowledge, skills, values, and attitudes over a specific medical topic.<sup>(7)</sup> Likewise, the development of correct clinical competencies on the undergraduate students depends on the gradual progression of their medical education, which –for its adequate development– has to be divided into four phases: a basic science phase, a clinical science phase, a practical training stage within a medical internship, and one year of obligatory social medical service.<sup>(8)</sup>

These educational phases, along with their professional competencies, could be measured by the Dreyfus & Dreyfus model, which classifies the clinical competence into five levels that go from novice to expert.<sup>(9-10)</sup> By considering the latter, along with the argument from the British Renal Society that establishes that the personal healthcare needs to have an adequate level of clinical skills in order to attend CKD patients,<sup>(11)</sup> it becomes necessary to identify and measure the competence level that the undergraduate students develop during their medical formation. Taking this last statement into consideration, we conducted the present study to measure the effect of a medical formation curriculum on Mexican undergraduate students, regarding their professional competencies for the identification and management of CKD.

## METHODS

### Study design

We carried out a quasi-experimental study of the pre-experimental type, based on the taxonomy proposed by Campbell and Stanley.<sup>(12-13)</sup> We used this study design to compare three groups against a fixed group, with the purpose of analyzing the effects of the Bachelor of Medicine (BM) curriculum from the Guadalajara LAMAR

University Campus Vallarta during the first scholar semester of 2019, which lasted from January to June (2019A cycle).

Because there was not any kind of intentional intervention on the biological, psychological or social variables of the participants, the study was classified as a “risk-free investigation”, according to the prescriptions of the national legislation of research.<sup>(14)</sup> Similarly, the research was approved by the Ethics and Research Committee of the Guadalajara LAMAR University, granting the institutional registry number 2018-03-02.

### Sample characteristics

For the selection of the participants we developed a non-randomized sample, which considered the inclusion of medical students of any age and sex enrolled at the Guadalajara LAMAR University during the specified time, regardless of their status as regular or irregular students as long as their enrollment was in effect at the time of the evaluation. Therefore, the selection of the three intervention groups depended in their attendance to the program, excluding those students who did not attend the appointment for the evaluation. Likewise, given the characteristics of the chosen study design, we didn't defined any elimination criteria.<sup>(6)</sup>

At the time of this study, the curriculum of the BM of the LAMAR University consisted of 65 courses equivalent to 419 credits, distributed in eight school semesters –with a total of 4,326 hours of classes– and divided into two subjects block: a “basic block”, which included the students from

first semester to third semester, and a final “clinic block”, including the students from the fourth to the final semester.<sup>(15)</sup> (**Table 1**)

Because of this, the sample resulted of 133 medical students, in which 18 were from the second semester of the medicine faculty, 31 were in at their fourth semester and 84 of them were at their medical internship. Second and fourth semester students were selected not only because they were available during the 2019A cycle, but also because both groups of students have contrasting types of courses, where second semester students are oriented towards more basic learning, fourth semester students already have an approach to the clinical medicine through their approach towards the community, as seen in **Table 1**.

Likewise, even though the medical internship is not contemplated as a course of the BM curriculum of the Lamar University, it's still part of the medical formation curriculum of every undergraduate medical student.<sup>(6)</sup> Because of this, we considered their participation during the research, not only due to their availability during the 2019A cycle, but also because their participation could allow us to understand their degree of clinical competencies, developed during their clinical training. Additionally, as part of a fixed group we included 22 college students from a private institution of upper secondary education who did not have any previous health knowledge, excluding those with minimal medical training or education. All the students from these semesters participated in the study, so we didn't have any losses because of elimination.

**Table 1.** Curriculum of the Bachelor of Medicine of the Guadalajara LAMAR University

Semester	Subjects or courses	Formation area	Total Hours	Credits
First (BB) <sup>1</sup>	Communication and technology	BCO*	32	3
	Research Methodology	BCO	64	7
	Public Health	BCO	64	7
	Human anatomy and dissections	BPO**	170	17
	Medic Biochemistry	BPO	170	18
	Embryology	BPO	68	7
	Histology	BPO	102	10

Semester	Subjects or courses	Formation area	Total Hours	Credits
Second (BB) <sup>1</sup>	Bioethics	BCO	64	7
	Psychology	BCO	64	7
	Human sexuality	BCO	48	5
	Health and Society	BCO	48	4
	Inferential Biostatistics	BCO	68	4
	Basic Molecular Biology	BCO	68	7
	Medical Physiology	BCO	170	20
	Laboral Health	BCO	34	20
	Public Health II	BCO	68	6
Third (BB) <sup>1</sup>	Epidemiology	BPO	64	6
	Medical Physiopathology	BPO	136	15
	Medical Genetics	BPO	100	10
	Medical Immunology	BPO	68	7
	Microbiology I	BPO	102	11
	Pathology	BPO	136	15
	Ambiental Health	BPO	40	3
Fourth (CB) <sup>2</sup>	Economy in Health	BPO	34	3
	Medical Pharmacology	BPO	68	9
	Health and legislation	BPO	34	3
	Evidence Based Medicine	BPO	34	3
	Microbiology II	BPO	68	7
	Nutrition and Society	BPO	34	3
	Promotion of Healthy Lifestyles	BPO	32	3
	Propaedeutic and medical sociology	BPO	204	20
	Child and adolescent health	BPO	68	5
	Health in the Community I	BPO	34	2
	Thanatology	OE***	34	3
Fifth (CB) <sup>2</sup>	Cardiology Clinic	BPO	68	7
	Dermatology Clinic	BPO	34	3
	Gerontogeriatrics Clinic	BPO	34	3
	Ophthalmology Clinic	BPO	34	3
	Otorhinolaryngology Clinic	BPO	34	3
	Urology Clinic	BPO	34	3
	Medical Clinic	BPO	170	18
	Surgical Clinic	BPO	170	18
	Health in the Community II	BPO	34	2
	Basic-Clinical integration seminar	BPO	34	2
	Prevention and family diagnosis	SP****	34	3
	Family Health	SP	34	3
	Alternative Medicine	OE	34	3

Semester	Subjects or courses	Formation area	Total Hours	Credits
Sixth (CB) <sup>2</sup>	Coloproctological clinic	BPO	34	3
	Infectology Clinic	BPO	34	3
	Nephrology and cardiovascular risk clinic	BPO	68	6
	Neumology Clinic	BPO	34	3
	Psychiatry Clinic	BPO	68	7
	Cardiovascular and Thorax clinic	BPO	34	3
	Clinic Research	BPO	34	3
	Health in the Community III	BPO	34	2
	Surgical techniques	BPO	68	6
	Pharmacological Therapeutics	BPO	102	11
Seventh (CB) <sup>2</sup>	Molecular biology in the clinics	BPO	34	3
	Oncology Clinic	BPO	34	3
	Sexual Medicine	BPO	34	3
	Preschooler and scholar pediatrics	BPO	102	10
	Health in the Community IV	BPO	34	2
Eight (CB) <sup>2</sup>	Gynecology and Obstetrics Clinic	BPO	170	12
	Forensic Medicine	BPO	34	3
	Medical Emergency	BPO	34	3
Total	65 subjects or courses		4,326	419
*BCO: Basic Common Obligatory; **BPO: Basic Particular Obligatory; ***OE: Open Elective ****SP: Specialized. <sup>1</sup> Basic Block; <sup>2</sup> Clinic Block. Source: Guadalajara LAMAR University				

### Variables and statistical methods

By taking into account the pre-experimental methodology exposed by Campbell and Stanley,<sup>(12)</sup> the curriculum of the BM from the LAMAR University was designated as the intervention, which presents an educational and methodological design based on the development of clinical competencies in the students through clinical simulations, early contact with patients, clinical practices and evidence-based case reports.

As a result of this, the second semester students were designated as Group 1 (G1) and received the intervention when they finished the 2019A cycle, which was designated as the “A” moment; the fourth semester students were the second group (G2) and received the intervention at the end of their courses, also known as the “B” moment; concluding with the third group composed of the medical interns (G3), who received the intervention when their medical internship

concluded in July of 2019, which was designated as the “C” time. Each of these groups were compared against each other and also to a fixed group (G0), who did not receive the intervention and was composed of the 22 college students.

Personal information about the participants, such as age and sex, was collected; likewise their clinical competencies were measured by means of a Spanish-language scale developed by Cabrera et al in 2005,<sup>(16)</sup> validated by experts and conceived through a perspective based on the integration of the medical theory into an adequate clinical decision making—which was previously used for the measurement of clinical competencies—.<sup>(17)</sup> This measurement scale consisted of 100 items, distributed into two clinical cases of diabetic nephropathy and one case of prerenal injury caused by hypovolemia. Through these cases, we sought to evaluate the undergraduate student’s clinical competencies with respect to their knowledge on

CKD risk factors and diagnosis, along with the detection of a proper clinical decision-making.

The measurement scale presented a reliability score of 0.74 according to the Kuder-Richardson coefficient, along with a Likert scale that ranged from 1 to 3 (“False”, “Correct” and “Unknown”)<sup>(16)</sup> where each correct answer was worth a point, an incorrect answer subtracted one point, and any “Unknown” answer was equal to zero. The final results of the questionnaire were obtained by adding all the correct answers and subtracting the incorrect ones.

Likewise, by taking the Dreyfus model as a consideration,<sup>(18)</sup> and by dividing the 100 questions into five sections, we grouped the answers into competencies levels according to the following cut-off points: points lower or equal to 20 -Which represented answers given by chance- meant “novice”, 21 to 40 points were the equivalent to “beginner advanced”, 41 to 60 points were a “competent level”, 61 to 80 points implied a “professional level”, and finally 81 to 100 points meant that the students were “experts” on the subject.

One week before the end of the 2019A cycle, the students of each group were informed about the characteristics of the survey; afterwards all the students were gathered in a designated classroom where we applied the instrument, which lasted no more than 50 minutes. The data obtained was analyzed using statistics descriptive to describe the sociodemographic characteristics of the students. Subsequently, we analyzed the percentage of success and clinical competencies by means of non-parametric inferential tests with 95% confidence (p-Value of  $\leq 0.05$ ) that used Chi squared test ( $\chi^2$ ).

## RESULTS

Of the total sample of 155 students, only 30 subjects were underage students, of which 22 were from the fixed group (G0) and the other 8 belonged to G1, being the rest of the sample students with an average age between 20 and 24 years old. Likewise, most of the students were of feminine gender; however, the female predominance was not statistically significant. (**Table 2**)

**Table 2.** Socio-Demographic characteristics of the students

Variables	G0*		G1**		G2***		G3****		p-Value <sup>a</sup>	
	No	%	No	%	No	%	No	%		
Age	15-19	22	100	8	44.4	0	0.0	0	0.0	<0.001
	20-24	0	0	10	55.6	31	100.0	68	80.1	
	25-29	0	0	0	0.0	0	0.0	15	17.9	
	30-34	0	0	0	0.0	0	0.0	1	2.0	
Sex	Female	15	68.2	7	38.9	18	58.1	43	51.2	0.274
	Male	7	31.8	11	62.1	13	42.0	41	48.9	

\* Fixed group; \*\* Second semester students; \*\*\* Fourth semester students; \*\*\*\* Interns; <sup>a</sup> According to the  $\chi^2$  test

**Table 3** shows the percentage of success –or correct answers- to identify and manage the CKD obtained in each study group, which was measured with the use of the instrument for clinical competencies. By simultaneously comparing all the groups, we observed that there was an increase in the percentage of correct answers obtained by G3 (54.8%), compared to G0 (18.2%). However, the increase in successes was not proportional since there was a slight decrease in G2 (41.9%) compared to G1 (44.4%).

Meanwhile, in **Table 4** we observe the level of clinical competencies for the identification and management of CKD for each group. Through this we identified that 81.9% of G0 belonged to the category of non-competent, while in G1 only 38.9% were competent. In G2 35.5% of students managed to be competent, and finally in G3 there was 62% of students with a level above the expected competition. Only three students from G3, and one from G2, achieved an expert level.

**Table 3.** Percentage of correct answers according to the established instrument

	G0*		G1**		G2***		G3****		p-Value <sup>a</sup>
	No	%	No	%	No	%	No	%	
Correct	4	18.2	8	44.4	13	41.9	46	54.8	0.024
Incorrect <sup>1</sup>	18	81.8	10	55.6	18	58.1	38	45.2	
Total	22	100.0	18	100.0	31	100.0	84	100.0	

\* Fixed group; \*\* Second semester students; \*\*\* Fourth semester students; \*\*\*\* Interns; <sup>1</sup> Sum of the frequencies of the categories "False" and "Unknown"; <sup>a</sup> According to the  $\chi^2$  test

**Table 4.** Clinical competence level on management of Chronic Kidney Disease

Clinical level (Cut-off point)	G0*		G1**		G2***		G3****		p-Value <sup>a</sup>
	No	%	No	%	No	%	No	%	
Expert Level ( $\geq 80$ )	0	0.0	0	0.0	1	3.3	3	3.6	<0.001
Professional Level (61-80)	1	4.5	3	16.7	5	16.1	14	16.7	
Competent Level (41-60)	3	13.6	4	22.2	5	16.1	35	41.7	
Beginner Level (21-40)	1	4.6	9	50.0	12	38.7	23	27.4	
Novice Level ( $\leq 20$ )	17	77.3	2	11.1	8	25.8	9	10.7	
Total	22	100.0	18	100.0	31	100.0	84	100.0	

\* Fixed group; \*\* Second semester students; \*\*\* Fourth semester students; \*\*\*\* Interns; <sup>a</sup> According to the  $\chi^2$  test

## DISCUSSION

Currently, the CKD is a worldwide epidemic and represents one of the most important challenges for the medical personal working in the public health systems, particularly in developing countries.<sup>(19)</sup> However, many patients with this disease are not opportunely diagnosed or even correctly treated;<sup>(20)</sup> because of this, previous research studies display the importance of educational interventions to increase the clinical competencies on the general practitioners, along with the medical students.<sup>(19)</sup>

To highlight this last argument, Latin-American studies that have worked with undergraduate students,<sup>(21)</sup> as well with medical residents, showed that the correct training of these students benefits to the early detection of clinical risk factors, both in the communities and in the primary care.<sup>(6, 21)</sup> With this in mind, this is the first study known by the authors in whom the effect of a BM curriculum

is evaluated both on medical students and in medical interns.

The comparison of our results against the results reported by Moreno-Segura et al, where the clinical aptitude and competencies of several Family Physicians was evaluated, allowed us to identify that the clinical knowledge that Family Physicians had about CKD had the lowest averages against other pathologies, almost equivalent to those obtained by the students from G3.<sup>(22)</sup> Despite the differences between the sample characteristics and the survey scales, the comparison between our results and this study enables us to understand that the clinical teaching of Family Physicians isn't very specific about certain medical pathologies, unlike other medical specialties where the clinical competence is higher.

According with the last statement, the research carried out by Surana et al in 2017, in which they

applied a survey scale to measure the clinical aptitudes and pharmacological knowledge of the medical residents from the Nephrology subspecialty, reflected that the competence level of the medical residents was above 90%, which contrasts with our results where we only reached a score of 54.8%.<sup>(23)</sup> The low results in our sample could be explained with what is exposed by Morena-Segura et al, who described that a low level of medical knowledge, or clinical skills, is due to a lack of clinical and practical integration,<sup>(21)</sup> which can only be achieved when the physician enters a more specialized educational level.<sup>(8)</sup>

However, another cross-sectional study, carried out by Casas et al, where the clinical aptitude of Family Physicians of the Mexican Institute of Social Security was evaluated, showed us that the knowledge and detection of degenerative diseases such as CKD was two times lower, compared to the G3's clinical competence. The reason for this contrast may be due to the fact that the research by Casas et al used a survey that evaluated the clinical knowledge of physicians according to the Mexican Clinical Practice Guidelines, which differs greatly from the evidence-based medical instrument that we applied, and is more based on the correct application of pre-established medical guidelines.<sup>(24)</sup>

Taking these comparisons into account, one of the advantages that come from our research is the detection of the percentage of students that reached a competent level, which was higher in the medical intern group than in the other one. Likewise, despite the fact that is reported that the Dreyfus model only reaches a competent level in undergraduate students –(Which explains why only 23 students achieved a professional level, and only four an expert level),<sup>(6)</sup> the usefulness of our results allowed us to understand the current level of clinical competencies that the students of Lamar University have throughout their education curriculum, which could also enable for the identification of educational deficiencies, that could be solved by the implementation of additional courses that seek to increase clinical and theoretical skills about CKD.

Yet, one of the main limitations that our research has results from the chosen research design, which does not allow us to prospectively observe the students, or understand any factors that conditions the results that we found –such

as the cause for the percentage of students that acquire an expert level–. Additionally, the same limitation that the Dreyfus model has, amongst undergraduate students, demands the need to use other educational models to measure the student competencies. Taking this into account, and apart from the proposals discussed above, we suggest future studies that allow the use for prospective or even retrospective follow-ups of the students, in order to identify new educational areas of improvement.

## CONCLUSION

This is the first study known by the authors in which the clinical competency of medical students regarding CKD was evaluated. We consider that the results obtained in the study were optimal, even though that the group with the highest scores –medical interns– didn't have a complete approach to the clinical practice yet. However, the comparison with other national studies and against specialized physicians, allowed us to identify the clinical competence of the medical students from the Lamar University and find areas of opportunity that can be corrected, which could allow a correct diagnostic integration that results in the proper use of therapeutic resources and to the improvement of future health care practice.<sup>(25)</sup>

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