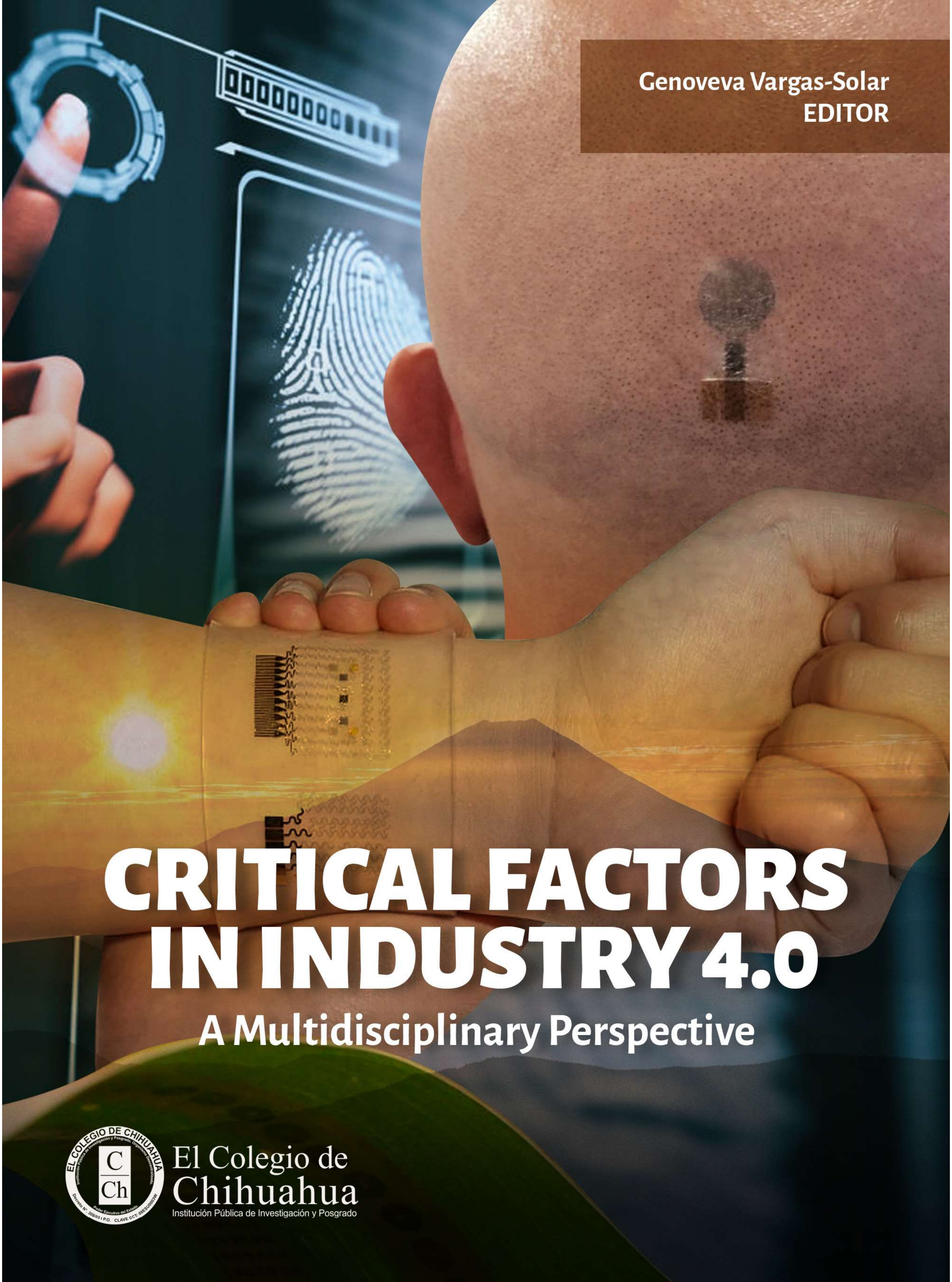

Genoveva Vargas-Solar
EDITOR

CRITICAL FACTORS IN INDUSTRY 4.0

A Multidisciplinary Perspective

El Colegio de Chihuahua
Institución Pública de Investigación y Posgrado

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Contents

CHAPTER 15

Study to Determine the Relationship Between Clinical Variables Associated with Infection and Death from Rickettsiosis in Mexicali, Baja California, Mexico

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Abstract. Worldwide, ticks are the second most common vector (after mosquitoes) in the transmission of infectious diseases to humans. In particular, the brown tick (Rhipicephalus sanguineus), found in several areas of Mexico, often takes the human body as an accidental host during its life cycle, causing serious public health problems. This is why health personnel should be familiar with the risk factors, signs and symptoms of tick-borne Rickettsiosis. Much of the complexity in mitigating Rickettsial infection because it can be difficult to diagnose since the symptoms are similar to those of other pathologies. At present, a timely and appropriate diagnosis depends largely on the clinical expertise of the primary care physician. On the other hand, Industry 4.0 and its main information and communication technologies are completely changing the world of services and production and it is to be expected that it will also affect the healthcare field. The internet of things, smart factory design, the use of Artificial Neural Networks (ANNs), health information systems, artificial intelligence, cloud computing and big Data, to mention a few, are increasingly enabling the digital transformation of medicine and healthcare, moving it towards Healthcare 4.0. The present research aims to provide new insights to enable early detection and prevention of deaths due to Rickettsiosis infection. A regression analysis was performed using the open source software R-studio on 1883 patients and the symptoms by which they were declared with possible Rickettsiosis in the municipality of Mexicali, Baja California, Mexico from 2014 to 2018. This study suggests a series of variables associated with both the acquisition of Rickettsiosis and death from the infection.

Keywords: Linear regression, R-studio, Healthcare, disease diagnosis, Rickettsiosis

Introduction

According to (Montesino Soraca et al., 2020), Industry 4.0 has its origin as a strategy that seeks the development of technology in the industrial sector, cost reduction and streamlining of internal processes while preserving their high quality. In this sense, medical care would benefit significantly from the implementation and integration of Industry 4.0 concepts and technologies, allowing, among other things, to provide better care to people and treat diseases in an optimal, fast and timely manner by creating efficient models for the diagnosis of diseases (Aceto et al., 2020; Montesino Soraca et al., 2020; Santacruz Fernández et al., 2019). Montesino Soraca et al. (2020), also highlights some applications and technologies of Industry 4.0 in the healthcare sector such as: Internet of Things, Smart Factories, ANN, Health Information Systems, Artificial Intelligence, Big Data, Cloud Computing and Augmented and Virtual Reality, to mention a few.

Furthermore, the application of artificial intelligence techniques, such as regression techniques, have been used in research (Blanton, 2019; Gerardi et al., 2019; Tena et al., 2018; Yaglom et al., 2018) to obtain relevant information on infectious diseases that represent a public health problem, such as vector-borne diseases (VBD). VBD represent more than 17% of all infectious diseases and cause more than 700,000 deaths per year worldwide (Who, 2017). The distribution of vector-borne diseases is determined by demographic, environmental and social factors (Who, 2017). Globally, ticks are the second most important vector, after mosquitoes, in the transmission of infectious diseases to humans (Chisu et al., 2018; Klein et al., 2017; Parola and Paddock, 2018)(Chisu et al., 2018; Klein et al., 2019; Parola & Paddock, 2018)[4]–[6]. All particular species and biotypes of ticks favor certain environmental conditions to determine their geographical distribution and, consequently, areas of risk for diseases transmitted by them (Almazan et al., 2016; Chisu et al., 2018; Parola and Paddock, 2018). The genus Rickettsia consists of different species of gram-negative bacteria and is framed within the Rickettsiaceae faimly. All species of the genus are intracellular parasites and are the cause of several epidemics worldwide (Bernabeu and Segura, 2005; Santamaría et al., 2018; Montenegro et al., 2017). The global impact of diseases caused by these microorganisms remains considerable due to their high prevalence and morbidity (Bernabeu and Segura, 2005; Casal et al., 2019; CDC, 2016; Tomassone et al.,). Although Rickettsia is considered a rural disease, it is increasingly common in urban areas (Bernabeu and Segura, 2005). During its life cycle, rickettsia infects several hosts, mostly mammals and vectors such as ticks and fleas. The most lethal of the febrile diseases is known as the Rocky Mountain Spotted Fever (RMSF) caused by Rickettsia Rikettsii (Parola and Paddock, 2018), in addition to this disease there are endemic typhus caused by Rickettsia typhi and epidemic typhus caused by Rickettsia prowazekii, all transmitted through vectors such as lice (R. prowazekii), ticks (R. rickettsii) and fleas (R. typhi) (Luce, 2015; Santamaria et al., 2018). Rickettsia rickettsii, R. prowazekii and R. typhi have been reported in Mexico, especially the brown tick (Rhipicephalus sanguineus) has been seen in several areas of the country (Escarcega et al., 2018) and during its cycle takes humans as an accidental host, causing serious public health problems. To date, they continue to cause serious problems and death in otherwise healthy adults and children, despite the availability of effective antibacterial therapy (CDC, 2016). Early recognition in the clinical course is critical as this is the period when antibacterial therapy is most effective. Early signs and symptoms of these diseases are nonspecific or resemble those of other diseases, which can hinder diagnosis, which becomes erroneous in most cases at the patient's first visit for medical care, even in areas where awareness of RMSF is high (Alvarez et al., 2017; Blanton, 2018; Buckingham et al., 2007; CDC, 2016; Souza et al., 2014) To increase the likelihood of early and accurate diagnosis, health care providers should be familiar with the risk factors, signs, and symptoms consistent with tick-borne rickettsial diseases (Blanton, 2018; Buckingham et al., 2007). In these cases, timely clinical diagnosis, careful evaluation of the epidemiological aspects of the disease, and appropriate patient care are determining factors in reducing the mortality rate (Oliveira et al, 2018; Traeger et al.,2015). Much of the complexity in mitigating Rickettsia infection is due to the diseases caused by this bacterium can be difficult to diagnose, as symptoms are common among other pathologies (Alvarez et al.,2017; CDC, 2016; Santamaria et al., 2018). RMSF, caused by Rickettsia rickettsii represents a health problem along the US-Mexico border as the incidence is higher in several northern Mexican states (Álvarez et al., 2017; Blanton, 2018; Casal et al., 2019; Escárcega et al., 2018; Sosa et al., 2016). Diagnosis is performed by serological tests specific for the Rickettsia group, which represents a challenge especially in disease endemic areas due to the occurrence of high levels of baseline antibodies (Kiran and Narang, 2018; Paris and Dumler, 2016; Paris et al., 2016). The most commonly used serological tests in the diagnosis of Rickettsiosis are the Polymerase Chain Reaction (PCR) which is widely used for its great versatility as an analysis technique in infectious diseases through molecular epidemiological studies (CDC, 2016; Ines et al., 2017; Gerardi et al., 2019; Montenegro et al., 2017). Likewise, there is also the Indirect Immunofluorescence (IIF) study, in which antibodies are detected between 7 and 10 days after the onset of the disease (Gerardi et al., 2019; Santamaría et al, 2018), which represents a risk for the patient since this disease can have severe clinical results and even become fatal in eight days if not treated in a timely manner (Casal et al., 2019; Traeger et al., 2015). The objective of this research is to find through the application of regression techniques, the relationship between the clinical variables that occur in patients diagnosed with Rickettsiosis, as well as the relationship of these with the evolution of the disease, i.e., whether it evolves favorably or dies; and to be able to contribute with new knowledge to improve the timely diagnosis of the disease in primary health care. That is, at the patient's first appointment with the physician.

This study was conducted in the municipality of Mexicali, Baja California, Mexico; a region with a high incidence of the disease since the first reported case in 2009 (Foley et al., 2019). Mexicali has a population of 1,059,896 inhabitants, distributed in 1650 localities of which 19 are considered urban and 1,631 are rural; 10 out of every 100 inhabitants of the municipality live in the latter (COPLADE, 2018). The climate of this region is categorized as very dry semi-warm registering temperatures of up to 50° Celsius in the months of July and August (INEGI, 2018). High temperatures with low humidity are recorded during most of the year (May-November) which is favorable for the increase of the brown tick population (Dantas,2010; Parola et al., 2008).

Methodology

To carry out this analysis, we worked with data obtained from 2014 to 2018 from patients in the municipality of Mexicali, Mexico, documented by the Department of Jurisdictional Epidemiology of the Ministry of Health of the State of Baja California. These patients initially presented symptoms of Rickettsiosis and, after the corresponding tests, they were ruled as positive or negative. The municipality of Mexicali is where most cases of Rickettsiosis have been registered in the state.The information was collected from different sources such as: epidemiological studies carried out by health institutions to study the prevalence of Rickettsiosis in the municipality of Mexicali and records of confirmed cases of Rickettsiosis.

In the case of epidemiological studies, the information included: patient identification data, notifying health unit, epidemiological data, clinical picture presented in each case, evolution in the hospital, results of laboratory studies, treatment and observations. Each case file examined had the format for immediate notification of probable cases of Rickettsiosis, specifically of RMSF. This form contains: patient identification data, hospitalization, risk factors such as overcrowding, garbage dump, dirty yard, unsafe housing, dirt floor and noxious fauna found in the patient's home, possible sources of exposure, chronological description of the symptoms presented, habits, contact with noxious fauna, consumption of drugs and/or alcohol, other diseases, first contact with health services, diagnosis and treatment. In addition to these data, the epidemiological study of cases of vector-borne diseases carried out by health institutions, laboratory tests confirming Rickettsiosis as a case and the concentrate of activities carried out by the health brigades, 5 blocks were integrated around the domicile of the reported case.

Two data sets were obtained from these sources: the first contains data on cases reported as probable (unconfirmed) cases of Rickettsiosis, which contains 1593 cases (rows) and 84 variables (columns). Some irrelevant variables for this study were eliminated, such as the personal data of the patients, among others; leaving 42 variables. Of these, 4 correspond to patient data, 26 to symptoms presented and 12 to variables with hospitalization data and laboratory tests. The second set of data was obtained from the information extracted from the personal files, compiled by the epidemiology department, of confirmed cases of Rickettsiosis. This set contains 290 cases (rows) and 72 variables (columns) of which: 4 correspond to patient data, 32 to symptoms presented, 14 correspond to risk factors found, 22 to data such as diagnosis in primary care, hospitalization data and results of laboratory tests performed. Both data sets are in digital format with Excel format. We worked with both files transforming the qualitative data into numerical data of those variables that we would use for the first statistical analysis.

Data mining with Principal Component Analysis

The Principal Component Analysis (PCA) technique was used to study the structure of the information in search of numerical patterns that generate a differentiation between the data. The central concept of PCA is to reduce the dimensionality of a data set, which consists of a large number of interrelated variables, while preserving as much of the variation present in the data set as possible. This is achieved by transforming a new set of variables, called principal components (PC), uncorrelated and ordered in such a way that the former retain the largest variation present in all the original variables. Formally, PCA is defined as an orthogonal linear transformation, which transforms the data into a new coordinate system such that the largest variance of any projection of the data is in the first coordinate (called the first principal component), the second largest variance in the second coordinate, and so on. In theory, the PCA is the optimal transformation for a given data set, in terms of least squares. The procedure for obtaining the main components can be summarized as follows: given a vector X^T of n dimensions, $X = [x_1 x_2 \ldots x_n]^T$, of which its stock vectors, M, and covariances, C, are described by: $M = E(X) = [m_1 m_2 \ldots m_n]^T$ and $C = E[(X - M)(X - M)^T]$. Calculate eigenvalues $\lambda_1, \lambda_2, \ldots, \lambda_n$, and the eigenvectors $P_1, P_2, \ldots, P_n$ and sort them according to their magnitude $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_n$. Select d eigenvectors to represent the n variables, $d < n$. Then $P_1, P_2, \ldots, P_d$ are called principal components. For the data set of the cases reported as probable of Rickettsiosis, the variables *Sex, Age, Cycle, Laoratory_Results, Fever, Headache, Malaise, Myalgias, Arthralgia, Retro_ocularPain, Rash, Pruritus, Vomit, Nauseus, Chills, Photophobia, AbdominalPain, Diarrhea, Conjunctivitis, NasalCongestion, Cough, Pharyngitis, Rhinitis, Hepatomega, Splenomega, Adenomegal, Hemorrhage, Convulsions* and Weakness are discrete variables; *Hto, HB*1, *PLAQ*1*xM* and *LEU* that are laboratory tests performed in the hospital and are continuous variables. As a result, a shift was performed to center the data at zero, and a scaling was performed to have a unit variance. The tool used for the PCA analysis was R-Studio. To perform the PCA, records containing null data in the variables *Hto, HB*1, *PLAQ*1*xM* and *LEU* were eliminated; so, 245 records and 34 variables were analyzed.

Regression Analysis

The regression model was the second tool used in our analysis, which is very useful to establish the correlation between two or more variables, as well as for measuring the degree of association or mutual variation between them (Perez, 2008; Wayne, 2005; Wonnacott, 1997). Multiple regression models are mathematical methods for modeling the quantitative stochastic relationship between a variable of interest and a set of explanatory variables. In general, these models can be expressed as follows (Rosner, 2011):

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots + \beta_p X_{ip} + \varepsilon_i$$

Where:

Y_i: interest variable, dependent or returning,

$X_{i1}, X_{i2}, \ldots, X_{ip}$: explicative variables, independent or regressive,
β_0: intersection or constant term,
$\beta_1, \beta_2, \ldots, \beta_p$: parameters, measure the influence that the explanatory variables have on the return,
p : number of independent parameters to be considered,
ε : observation error due to uncontrolled variables,
i: $1,2,\ldots,n$: number of observations of the variables.

With these models it is possible to study the linear relationships between multiple variables and the effect they have on the dependent variable. They are estimated following the least squares criterion:

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{i1} + \hat{\beta}_2 X_{i2} + \cdots + \hat{\beta}_p X_{ip}$$

$$e_i = Y_i - \hat{Y}_i = Y_i - \left(\hat{\beta}_0 + \hat{\beta}_1 X_{i1} + \hat{\beta}_2 X_{i2} + \cdots + \hat{\beta}_p X_{ip}\right)$$

$$\min_{\substack{\beta \in n \\ i=1,\ldots,n}} \sum_{i=1}^{n} e_i^2 = \left(Y_i - \hat{\beta}_0 - \hat{\beta}_1 X_{i1} - \hat{\beta}_2 X_{i2} - \ldots - \hat{\beta}_p X_{ip}\right)^2$$

And the least squares estimators are obtained from the equation:

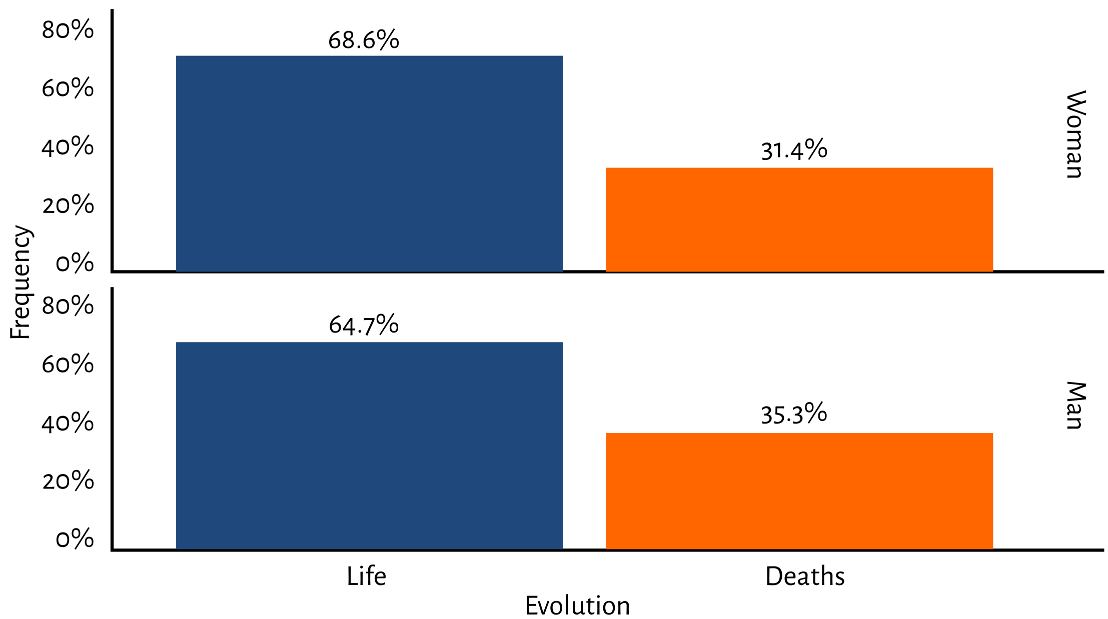
$$\hat{\beta} = (X^T X)^{-1} X^T Y$$

Results

Descriptive statistical analysis:

As a first step, a descriptive statistical analysis was carried out using R-Studio software as a tool. Of the set of 290 cases confirmed with Rickettsiosis, 150 (51.72%) were men and 140 (48.28%) women. Figure 1 shows the bar graph with the percentages of deceased and surviving patients of men and women. The red bars show the patients alive, of which 68.6% are women and 64.7% are men; and the blue bars show the deceased patients, of which 31.4% are women and 35.3% are men.

Figure 1. *Gender description of living and deceased patients.*



Source: *Own elaboration.*

A second examination was performed analyzing the variable place of the rash, which describes the place of the body where the rash began, a characteristic symptom in patients with Rickettsiosis. Table 1 shows the numerical classification that was assigned to each place of the body where the patient refers to the appearance of rash.

Table 1. *Numerical assignment for each place on the body where the patient refers the appearance of a rash.*

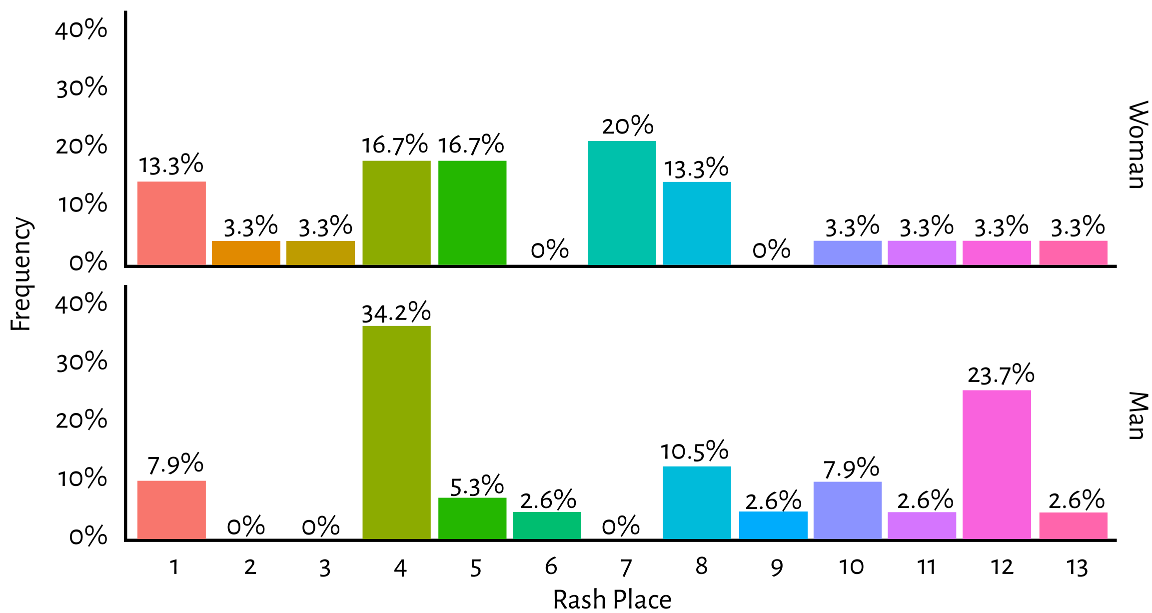
Rash_Place	
1= Abdomen	8= Upper and lower extremities
2= Abdomen and posterior chest	9= Upper extremities and abdomen
3= Abdomen, wrists and posterior chest	10= Upper extremities and chest
4= Body (no place specified)	11= Limbs and abdomen
5= Lower extremities	12= Chest
6= Lower extremities and Abdomen	13= Chest and y abdomen
7= Upper Extremities	

Source: *Own elaboration.*

Figure 2 shows the result of this analysis graphically, in which men and women were analyzed separately and it was observed that 20% of the women presented the upper extremities rash (7, according to table 1), 16.7% presented rash in the body without specifying place (4) as well as in lower extremities (5) 16.7%, on the other hand, 13.3%

presented rash in abdomen (1) and upper and lower extremities (8). In the case of men, 34.20% indicated that the rash began in the body (4, according to table 1); however, it is not specified in which part of the body the rash was presented. 23.7% indicated that the rash started in the chest (12, according to table 1). 10.5% in upper and lower extremities (8) and 7.9% reported having presented rash in abdomen (1) and upper extremities and chest (10).

Figure 2. *Percentages of appearance of rash in patients.*



Source: *Own elaboration.*

The following examination was performed with the symptoms reported by patients confirmed with Rickettsiosis chronologically, which coincided with the main clinical manifestations indicated in the literature (Casal et al., 2019; Klein et al., 2017). Of the 290 cases recorded in our data set, those that did not contain any symptoms were eliminated, leaving 126 cases. Many patients had no documented symptoms because during the years 2014 and 2015 the patient interview was not conducted. The variables cited in the literature were taken as indicators of Rickettsia, in addition to others found as constants in the interviewed patients, leaving 12 symptoms to be analyzed. To inspect the time of appearance of each symptom was performed in hours. Table 2 presents the results obtained.

Table 2. Descriptive statistics of the symptoms analyzed in this study, in patients with Rickettsiosis. Standard deviation (SD), Mean in hours (Mean).

Time in hours		Fever	Rash	Headache	Myalgia	Malaise	Arthralgias	Nauseous	Vomit	Stomach ache	Weakness	Diarrhoea	Confusion	Cough
Man	Mean	38.04	114.67	30.55	67.58	64.42	98.40	81.78	86.71	91.38	72.00	91.00	160.94	72.00
	SD	28.02	43.08	14.97	47.30	49.31	63.14	59.26	68.36	61.48	60.54	78.80	49.31	67.88
Woman	Mean	46.67	104.00	48.57	83.66	62.55	98.67	75.56	81.82	80.64	91.20	91.20	154.91	72.00
	SD	51.16	56.26	61.70	64.39	54.97	70.23	54.77	47.80	51.32	70.99	68.63	69.03	63.50
Live	Mean	39.88	99.43	39.86	77.02	60.28	99.43	74.25	86.25	90.16	90.46	72.00	146.40	66.00
	SD	40.12	50.85	41.01	59.15	49.51	72.09	52.21	65.05	63.09	74.77	68.38	68.38	53.22
Deaths	Mean	46.77	127.74	38.40	72.80	68.57	79.30	85.09	82.29	75.43	72.00	112.5	165.33	78.00
	SD	43.68	43.11	52.58	52.91	55.32	51.39	63.16	53.44	32.41	54.43	78.25	59.87	76.84

Source: *Own elaboration.*

Table 3 shows the mean time in hours of onset of symptoms, as well as the frequency with which symptoms occurred in the 126 cases of patients with rickettsiosis.

	Mean (Hours)	Standard Deviation (Hours)	Frequency	%
Rhinorrhea	36.0	17.0	2	1.6%
Headache	39.3	45.1	86	68.3%
Nasal congestion	40.0	12.0	9	7.1%
Fever	42.4	41.4	107	84.9%
Dysphagia	44.0	17.2	12	9.5%
Sleepiness	56.0	40.3	18	14.3%
Earache	56.0	55.4	3	2.4%
Pharyngeal pain	57.6	32.2	5	4.0%
Malaise	63.5	51.6	71	56.3%
Cough	72.0	61.5	8	6.3%
Myalgia	75.3	56.3	73	57.9%
Nauseous	78.7	56.6	54	42.9%
Anorexia	81.9	70.7	34	27.0%
Weakness	82.0	66.2	48	38.1%
Vomit	84.7	60.2	53	42.1%
Abdominal pain	86.1	56.4	51	40.5%
Photophobia	86.4	67.0	5	4.0%
Asthenia	90.0	76.0	12	9.5%
Diarrhoea	91.1	74.9	34	27.0%
Adynamia	96.0	74.7	14	11.1%
Arthralgias	98.5	66.0	57	45.2%
Rash	109.5	49.9	87	69.0%
Petechiae	126.7	64.7	18	14.3%
Prostration	133.5	56.8	16	12.7%
Pruritus	136.0	77.1	3	2.4%
Delirio	154.9	55.1	11	8.7%
Confusion	158.6	56.7	28	22.2%
Convulsions	163.8	51.8	17	13.5%
Stiff Neck	192.0	0.0	1	0.8%

Source: *Own elaboration.*

From the results in Table 3, we observe that in chronological order of appearance of the symptoms and by the frequency in which the symptoms occurred, 68.3% of the patients reported having had a headache around 39 hours after the symptoms started, 84.9% had a fever around 42 hours, 56.3% had general malaise around 63 hours, 57.9% had myalgia around 75 hours, 42.9% had nausea around 78 hours, 42.1% had vomiting around 84 hours, 40.5% presented abdominal pain around 86 hours, 45.2% presented arthralgias around 98 hours, 69% presented rash around 109 hours, it is worth mentioning that this symptom is the third symptom with higher frequency only after fever and headache according to the analyzed data.

Data mining with Principal Component Analysis

To visualize the structure of the data by means of information clusters, a Principal Components Analysis (PCA) was applied and graphs were generated contrasting the obtained components. A labeling of the points of the graph was made with different variables of the data set, in order to see if any of them is the one that generates this distribution. In most of the variables analyzed, it was not observed that any variable defined the distribution of the data.

Regression Analysis

To measure the relationship between the variable (live/death) with the variables sex, age, laboratoryresponse (if positive or negative to the IIF and PCR serological tests), symptoms, as well as the blood count data performed during hospitalization (*HTO*, *HB*, *platelets and leukocytes*). A linear regression analysis was performed, resulting in the variables *Platelets, Age, Hemorrhage and Convulsions* with a very high degree of statistical significance, *pvalue*<0.001(***); the variables abdominal pain, laboratory tests (IIF/PCR), *diarrhea* and *malaise* with a high degree of significance, 0.001<*pvalue*<0.01(**) . Similarly, the variables *Arthralgias*, *Vomit*, *Hepatomegaly*, *Retro-ocularPain*, *Icterice*, and *Myalgias* were statistically significant, 0.01<*valorp*<0.05(*). Table 4 shows the results obtained.

Table 4. Variables associated with the variable (Live/Defunction) according to their degree of significance. Source: Own elaboration.

Variables	P value of the variable CYCLE (Live/Death)	Significance Codes 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'
Platelets 1 X M	2.71E-07	***
Age	7.90E-06	***
Hemorrhage	5.50E-05	***
Convulsions	0.000658	***
Abdominal pain	0.00528	**
Lab tests	0.00656	**
Diarrhoea	0.00674	**

Variables	P value of the variable CYCLE (Live/Death)	Significance Codes 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'
Malaise	0.00696	**
Arthralgias	0.0273	*
Vomit	0.0285	*
Hepatomegaly	0.0352	*
Retro-ocular Pain	0.0363	*
Ictericia	0.0365	*
Myalgia	0.0465	*
Headache	0.0954	.
Cough	0.0956	.
Pruritus	0.0999	.

Similarly, to measure the relationship between the *laboratoryresponse* variable (Positive/Negative) with the variables of *sex*, *age*, *cycle*, (if the patient recovered or died), symptoms, as well as the blood count data performed during the hospitalization (*HTO*, *HB*, *platelets* and *leukocytes)* a linear regression analysis was performed, in which the *cycle* and *age* variables with very high degree of statistical significance were found *pvalue*<0.001(***); the *platelet* and *hemorrhage* variables resulted in a high degree of significance, 0.001<*pvalue*<0.01(**); and similarly the *diarrhea*, *chills* and *arthralgia* variables were statistically significant, 0.01<*pvalue*<0.05(*). Table 5 shows the results obtained.

Table 5. *Variables associated with the variable (Positive / Negative) for Rickettsiosis according to their degree of significance.*

Variables	P value of the variable LAB_ RESPONSE (Positive / Negative)	Significance Codes
Cycle	5.46E-08	***
Age	0.00019	***
Platelets 1 X M	0.00402	**
Hemorrhage	0.00668	**
Diarrhoea	0.0289	*
Chills	0.0303	*
Arthralgias	0.0438	*

Continued...

Variables	P value of the variable LAB_ RESPONSE (Positive / Negative)	Significance Codes
Malaise	0.0594	.
Rash	0.0615	.
Nasal congestion	0.0928	.
Convulsions	0.0977	.

Source: *Own elaboration.*

Conclusions

Industry 4.0 seeks to benefit more than one sector of society with the implementation of concepts and technology that allow process improvement and reduction of errors, without losing the quality of the process. In this sense, the implementation of Industry 4.0 in the health sector in Mexico, would improve both primary care services in hospitals and access to clinical data information of patients between health institutions, as well as being able to have remote medical care in places of difficult access and to have a correct and timely diagnosis of diseases. This document presents a first analysis of the clinical information of 1,883 cases of patients who presented symptoms due to possible Rickettsiosis in the municipality of Mexicali, Baja California, Mexico. For the information analysis, descriptive statistics of patients with similar behavior in the period of 2014 to 2018 were computed. Results showed a fatality rate of 12.40% in women and 13.41% in men. Other analyses included the calculation of the percentage of patients who presented the symptom of exanthema in different parts of the body; inspection of 13 common symptoms of Rickettsiosis; and the computation of the average times of appearance of symptoms in patients. In a second analysis, data mining was performed using the Principals Components technique. The results did not show a clear influence of any variable on the distribution of the data. Finally, an association analysis using regression techniques on different variables of interest, with the result of the diagnosis by laboratory tests (whether the patient was positive or negative for Rickettsiosis) and the evolution of the infection (whether the patient died or survived), was carried out.Six variables were very highly associated (*platelets, age, bleeding, seizure, cycle and age*), six more highly associated (*abdominal pain, laboratory tests* (IIF/PCR), diarrhea, malaise, platelets and hemorrhage) and nine were normally associated (*arthralgias, vomit, hepatomegaly, retro-ocular pain, jaundice, myalgia, diarrhea, chills and arthralgia*). Finally, this study suggests a series of variables associated with both the acquisition of Rickettsiosis and death due to infection, which may, under a subsequent analysis, be declared as risk factors for acquisition and death by Rickettsiosis in the population of Baja California, this can be determined in future research, seeking to make a contribution to improve techniques to make a correct diagnosis in primary health care. Critical situation so far, since in the analyzed cases we found that the average time in which patients attended a health service is 3 days, however, only 23.17% of patients received a correct diagnosis, delaying this the start of antibiotic treatment (doxycycline), which potentializes severe irreversible damage to multiple organs. Improving the quality of medical care, the access to clinical patient information and diagnostic protocols for diseases such as Rickettsiosis, are aspects still pending in health institutions, therefore promoting the implementation of Industry 4.0 would generate new methods for the prevention, diagnosis and timely treatment of diseases, guaranteeing people a better quality of life.

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