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# Physiologic parameters and severe maternal morbidity in acute pyelonephritis

## *Parâmetros fisiológicos e morbidade materna severa na pielonefrite aguda*

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### Abstract

#### Objective

This study aimed to evaluate vital parameters related to severe maternal morbidity due to acute pyelonephritis.

#### Methods

Retrospective cross-sectional study of in-hospital cases under acute pyelonephritis treatment allocated as improvement in ward or Intensive Care Unit (ICU) admission from January 2014 to December 2018. Vital data were compared regarding means and predetermined abnormal parameters from warning systems described in literature, statistically significance considered  $p < 0.05$ . Odds Ratio (OR) with 95% confidence intervals (95% CI) were estimated to examine the effect of the variables on Intensive Care Unit admission.

#### Results

We studied 335 cases, no deaths recorded and a 5.9% rate ( $n=20$ ) of Intensive Care Unit admission; these were younger ( $22.0 \pm 4.8$  vs.  $24.6 \pm 5.3$  years;  $p=0.022$ ) and more frequently in their first pregnancy (55% vs. 9.8%;  $p < 0.001$ ). There was significant difference between groups regarding heart rate (HR), blood oxygen saturation (SpO<sub>2</sub>) and respiratory rate (RR) means; under the abnormal classification, these were the most prevalent parameters in the ICU group. Cases were more likely admitted to ICU when HR  $\geq 100$  bpm (OR=30.5, 95% CI 8.6–108.1), diastolic blood pressure (DBP)  $< 50$  mmHg (OR=16.4, 95% CI 5.3–50.0) and RR  $\geq 22$  bpm (OR=13.4, 95% CI 4.8–37.3). Critical interventions in ICU cases accounted for 65% ( $n=13$ ) mechanic ventilation, 40% ( $n=08$ ) of vasopressors administration and 25% ( $n=05$ ) of hemotherapy.

#### Conclusion

Altered HR, RR and SpO<sub>2</sub> were the most frequent variables in ICU admission group and HR  $\geq 100$  bpm, DBP  $< 50$  mmHg and RR  $\geq 22$  bpm were the parameters more likely associated to this outcome.

**Keywords:** Intensive care units. Maternal health. Near miss, healthcare. Pregnancy complications. Pyelonephritis. Vital signs.



## Resumo

### Objetivo

Avaliar parâmetros vitais relacionados à morbidade materna grave decorrente de pielonefrite aguda, enquanto estratégia para melhoria de assistência obstétrica.

### Métodos

Estudo transversal e retrospectivo de casos hospitalares de pielonefrite aguda alocados em melhora em enfermaria ou admissão em Unidade de Terapia Intensiva (UTI), de janeiro de 2014 a dezembro de 2018. Dados vitais dos casos foram comparados sob médias e parâmetros pré-estabelecidos como alterados de sistemas de alerta descritos em literatura, com significância estatística quando  $p < 0,05$ . Foram calculados Odds Ratio (OR) e respectivos intervalos de confiança 95% (IC 95%) para examinar o efeito das variáveis sobre admissão em UTI.

### Resultados

Estudou-se 335 casos, sem óbitos registrados e com 5,9% ( $n=20$ ) de admissão em UTI; estas foram mais jovens ( $22,0 \pm 4,8$  vs.  $24,6 \pm 5,3$  anos;  $p=0,022$ ) e mais frequentemente primigestas (55% vs. 9,8%;  $p < 0,001$ ). Frequência cardíaca (FC), saturação periférica de oxigênio (SpO<sub>2</sub>) e frequência respiratória (FR) apresentaram diferença significativa sob as médias entre os grupos; classificados como alterados, foram os parâmetros mais prevalentes no grupo UTI. Observou-se maior associação de admissão em UTI com FC  $\geq 100$ bpm (OR=30,5, IC 95% 8,6–108,1), pressão arterial diastólica (PAD)  $< 50$ mmHg (OR=16,4, IC 95% 5,3–50,0) e FR  $\geq 22$ mrpm (OR=13,4, IC 95% 4,8–37,3). Casos com intervenções críticas em UTI contabilizaram 65% ( $n=13$ ) de ventilação mecânica, 40% ( $n=08$ ) de uso de vasopressores e 25% ( $n=05$ ) de hemoterapia.

### Conclusão

Alterações em FC, FR e SpO<sub>2</sub> estiveram presentes em maior frequência nos casos com admissão em UTI e os critérios de FC  $\geq 100$ bpm, PAD  $< 50$ mmHg e FR  $\geq 22$ mrpm apresentaram maior associação para este desfecho.

**Palavras-chave:** Unidades de terapia intensiva. Saúde materna. Near miss. Complicações na gravidez. Sinais vitais. Pielonefrite.

## Introduction

Maternal morbidity events comprise any health condition that are attributed to pregnancy or childbirth, or aggravated by them, determining negative impact on women wellbeing [1]. Within a progressive worsening scale, such conditions evolve to potentially life-threatening and, further on, life-threatening conditions. Possible outcomes will be maternal death or health recovery, and the latter are described as maternal near miss cases [2,3]. Severe maternal morbidity classification embraces potentially life-threatening conditions and their developments and in practical terms maternal near miss and severe maternal morbidity are interchangeable concepts [3].

One frequent condition during pregnancy is urinary tract infection, usually confined to the lower urinary tract and with a benign evolution with appropriate treatment; however, ascendant invasion to the upper urinary tract may occur and determine acute pyelonephritis, described as a relevant cause of maternal sepsis and septic shock, along with pneumonia the most frequent non obstetric etiologies during pregnancy and postpartum [4-6].

Maternal sepsis is defined as a life-threatening condition during pregnancy, childbirth, post-abortion or postpartum period, characterized by organ dysfunction resulting from confirmed or suspected infection [7]. Sepsis cases are classified as severe maternal morbidity, often requiring management in Intensive Care Unit (ICU) and standing as important cause of maternal death [3,7-9].

Review of maternal morbidity events may provide elements to improve quality in obstetric care as exemplified by warning systems [2,10]. These are based on the principle that the cluster of variables that reflect minor physiologic changes may be noticed before the perception of an only major abnormality within morbidity progression and indicate risk of clinical deterioration [11].

Warning systems thus offer a window of opportunity to execute interventions that will ultimately result in morbidity and mortality reduction [12,13].

Despite the development of several warning systems, there is no consensus to date over the most suitable one to estimate severe maternal morbidity, taking in account the broad range of existent etiologies. Due to the complexity of this topic, additional research is recommended [14,15].

This study aimed to investigate and to compare maternal vital data of in-hospital cases admitted for acute pyelonephritis treatment with the outcomes of severe morbidity (urosepsis) with subsequent ICU transfer or clinical improvement without ICU transfer (improvement in ward).

## Methods

This is a retrospective cross-sectional study based on data collected from hospital records from January 1st, 2014 to December 31st, 2018. Facilities included were Maternidade Darcy Vargas and Hospital Regional Hans Dieter Schmidt, both located in Joinville, Santa Catarina, Brazil. The research was approved by the Research Ethics Committee of Hospital Regional Hans Dieter Schmidt, CAAE: 20010219.5.0000.5363, accordingly to the National Health Council resolution nº 466/2012, and feasibility declaration was granted from the Technical Board of Maternidade Darcy Vargas.

The study included cases of women over 18 years old, pregnant or during postpartum up to 42 days of pregnancy termination, admitted for clinical treatment of acute pyelonephritis considering diagnostic criteria of urinary tract infection in laboratory exams, either positive urinalysis or positive uroculture, in association to costovertebral angle tenderness, flank pain or axillar temperature of  $\geq 38^{\circ}\text{C}$  [16,17]. Recurrent admissions of the same patient due to acute pyelonephritis were analyzed as distinct cases.

Morbidity progression was investigated for outcomes of urosepsis while in the initial facility of admission and transfer to Hospital Regional Hans Dieter Schmidt, since it offers ICU support (ICU admission group) or clinical improvement in ward without ICU transfer (improvement in ward group).

Cases were excluded when there was no access to proper data collection, loss of follow-up or when hospital transfer was planned and not related to clinical worsening. Data collected correspond to registries on the moment of transfer solicitation for the ICU admission group or hospital discharge for the improvement in ward group.

Quantitative data were described in means and standard deviations and, once normal distribution was tested by Kolmogorov-Smirnov test, groups were compared by Mann-Whitney U test when normality was rejected or Student t-test for normal distributed data. Qualitative variables were described in absolute and relative frequencies and groups were compared using chi-square test or Fisher's exact test, for frequencies under 5 elements.

Warning system variables from existing literature were applied with emphasis to sensibility and vital data from both groups were compared using cutoff values previously stipulated as "abnormal":

– Axillar temperature  $< 36^{\circ}\text{C}$  from Irish Maternal Early Warning Score (IMEWS) [13], Maternal Early Warning Trigger (MEWT) [14] and Sepsis in Obstetrics Score (SOS) [18], or  $\geq 38^{\circ}\text{C}$  from IMEWS [13] and Modified Obstetric Early Warning Score (MOEWS) [19];

- Systolic Blood Pressure (SBP)  $\leq 90$ mmHg, from SOS [18];
- Diastolic Blood Pressure (DBP)  $< 50$ mmHg, from IMEWS [18];
- Estimated Medium Arterial Pressure (MAP)  $< 70$ mmHg, from obstetrically modified Sequential Organ Failure Assessment (omSOFA) [20];
- Heart Rate (HR)  $\geq 100$ bpm, from Modified Early Obstetric Warning System (MEOWS) [11], IMEWS [13] and Early Maternal Infection Prompts (EMIP) [15];
- Respiratory Rate (RR)  $\geq 22$ bpm, from quick Sequential Organ Failure Assessment (qSOFA) [21];
- Oxygen saturation  $< 96\%$  on room air, from IMEWS [13], or use of oxygen supplement to maintain oxygen saturation  $\geq 96\%$ , from MOEWS [19];
- Mental status registered as poor general status, confusion or unresponsiveness, from MEOWS [11], IMEWS [13], MEWT [14], omSOFA [20], qSOFA [21] and MEWC [22].

Logistic regression models were applied to evaluate the relevance of the effect of the variables determined as “abnormal” to the outcome of ICU admission by Odds Ratio (OR) with 95% confidence interval (95% CI) and p-values  $< 0.05$  were considered significant.

## Results

During the study period, 335 cases were analyzed with 94.0% (n=315) allocated in the improvement in ward group and 5.9% (n=20) in the ICU admission group. No maternal deaths were recorded and recurrent acute pyelonephritis was observed in 4.7% of women (n=16).

Comorbidities were observed in 33.7% of the total cases (n=113) and previous episode of acute pyelonephritis in 11.9% of the total cases (n=40). Table 1 shows clinical and epidemiological characteristics and Table 2 demonstrates vital parameters of the studied cases, described in means and standard deviations and accordingly to criteria stipulated as “abnormal”, in agreement to the study methods.

Multivariate analysis for identification of vital parameters associated to ICU admission is shown in Table 3.

**Table 1** - Clinical and epidemiological characteristics of maternal cases hospitalized for acute pyelonephritis treatment with outcomes of ICU admission or improvement in ward without ICU transfer.

Maternal characteristic	ICU admission		Improvement in ward		p-value
	n=20	%	n=315	%	
<b>Maternal age (years, mean<math>\pm</math>SD)</b>	22.0 $\pm$ 4.8		24.6 $\pm$ 5.3		0.022 <sup>†</sup>
Civil status “unmarried”	11	55.0	138	43.8	0.329 <sup>‡</sup>
Educational over elementary level	13	65.0	229	72.7	0.456 <sup>‡</sup>
Primigravida	11	55.0	31	9.8	$< 0.001^{\ddagger}$
Gestational period					
1 <sup>st</sup> trimester	-	-	27	8.6	0.388 <sup>*</sup>
2 <sup>nd</sup> trimester	12	60.0	151	47.9	0.295 <sup>‡</sup>
3 <sup>rd</sup> trimester	07	35.0	130	41.3	0.580 <sup>‡</sup>
Postpartum	01	5.0	07	2.2	0.392 <sup>*</sup>
Comorbidities present	08	40.0	105	33.3	0.541 <sup>‡</sup>
Previous acute pyelonephritis	04	20.0	36	11.4	0.278 <sup>*</sup>

Note: \*Fisher’s exact test. <sup>†</sup>Mann-Whitney test. <sup>‡</sup>Chi-square test. ICU: Intensive Care Unit; n: number of cases; SD: Standard Deviation.

**Table 2** – Vital parameters of maternal cases hospitalized for acute pyelonephritis treatment with outcomes of ICU admission or improvement in ward without ICU transfer.

Clinical parameter	ICU admission (n=20)	Improvement in ward (n=315)	p-value
Axillar temperature (°C)	36.4±1.1	36.2±0.5	0.466 <sup>†</sup>
<36°C or ≥38°C; n (%)	06 (30.0)	72 (22.9)	0.192 <sup>‡</sup>
Systolic blood pressure (mmHg)	100.3±21.5	103.6±11.5	0.155 <sup>††</sup>
≤90mmHg; n (%)	08 (40.0)	30 (9.5)	0.001 <sup>†</sup>
Diastolic blood pressure (mmHg)	58.4±19.7	64.6±9.5	0.062 <sup>††</sup>
<50mmHg; n (%)	07 (35.0)	10 (3.2)	<0.001 <sup>†</sup>
Estimated mean blood pressure (mmHg) <sup>a</sup>	71.9±19.8	77.3±9.7	0.074 <sup>††</sup>
<70mmHg; n (%)	09 (45.0)	43 (13.7)	0.001 <sup>†</sup>
Heart rate (bpm)	118.8±20.7	92.7±21.2	<0.001 <sup>†</sup>
≥100bpm; n (%)	17 (85.0)	49 (15.6)	<0.001 <sup>†</sup>
Respiratory rate (bpm)	25.9±5.8	21.8±4.7	<0.001 <sup>†</sup>
≥22mrpm; n (%)	13 (65.0)	41 (13.0)	<0.001 <sup>†</sup>
Oxygen (O <sub>2</sub> ) saturation (%) <sup>b,d</sup>	91.3±5.7	95.7±3.9	0.001 <sup>†</sup>
<96% or O <sub>2</sub> use to maintain ≥96%; n (%)	15 (75.0)	20 (6.3)	<0.001 <sup>†</sup>
Mental status <sup>c</sup>	Normal	normal	0.207 <sup>†</sup>
altered; n (%)	01 (5.0)	01 (0.3)	0.030 <sup>†</sup>

Note: Fisher's exact test. <sup>†</sup>Mann-Whitney test. <sup>‡</sup>Chi-square test. <sup>††</sup>Student t-test. ICU: Intensive Care Unit; n: number of cases. <sup>a</sup>Estimated mean blood pressure calculated using systolic and diastolic blood pressure. <sup>b</sup>Oxygen saturation evaluated on room air, sea level. <sup>c</sup>"Normal" mental status: good general status, alert; "altered" mental status: poor general status, confusion or unresponsiveness. <sup>d</sup>Oxygen saturation: no data registered in 78.4% (n=247 cases) in the improvement in ward group and in 5% (n=01) in the ICU admission group.

**Table 3** – Multivariate analysis of maternal cases hospitalized for acute pyelonephritis treatment for identification of vital parameters associated to ICU admission.

Parameter	ICU admission (n) / Improvement in ward (n)	Odds Ratio	95% CI	p-value
SPB ≤90mmHg	08 / 30	6.3	2.4–16.7	<0.001
DBP <50mmHg	07 / 10	16.4	5.3–50.0	<0.001
MAP <70mmHg	09 / 43	5.1	2.0–13.2	0.001
HR ≥100bpm	17 / 49	30.5	8.6–108.1	<0.001
RR ≥22bpm	13 / 41	13.4	4.8–37.3	<0.001
SpO <sub>2</sub> <96%	15 / 20	9.0	2.6–30.4	<0.001

Note: ICU: Intensive Care Unit; n: number of cases; 95% CI: 95% Confidence Interval; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MAP: Estimated Mean Arterial; HR: Heart Rate; RR: Respiratory Rate; SpO<sub>2</sub>: Oxygen Saturation on Room Air, Sea level, and cases in use of oxygen supplement to maintain saturation ≥96%.

Initial antibiotic therapy consisted of ampicillin sodium and sulbactam sodium association in 93.4% of cases (n=313), without significant difference between ICU admission group and improvement in ward group (respectively 100% of cases, n=20, and 93% of cases, n=293; p=0.221). Antibiotic therapy was changed on the grounds of treatment adjustment due to therapeutic failure or uroculture with antibiogram results in 14 of 20 cases in the ICU admission group and in 29 of 315 cases of the improvement in ward group, with significant difference between them (p<0.001).

Mean hospital stay was 1.4±0.8 days in the ICU admission group from hospital admission to solicitation to transfer and 3.9±2.0 days in the improvement in ward group from hospital admission to discharge.

Critical interventions related to life-threatening events [2] were executed in 65% of cases (n=13) in the ICU admission group: mechanic ventilation occurred in 60% of cases (n=12, 3.5% of the total sample), vasopressors were administered in 40% of cases (n=08, 2.2% of the total sample) and hemotherapy was performed in 25% of cases (n=05, 1.4% of the total sample).

## Discussion

The rate of ICU admission in this study was similar to the literature, with indexes ranging from 1.75% [23] to nearly 10% [16] of ICU admission and 22% to high-dependency units (jointly described as severe maternal morbidity) arising from acute pyelonephritis complications [24]. This indexes variation may be explained by the variability of health resources [3] and by the heterogeneity of criteria applied to intensive care transfer [3,10,25].

Both rate of recurrent acute pyelonephritis [16,23] and absence of maternal deaths [26] are described by literature, where maternal mortality indexes due to sepsis or septic shock tend to be lower than the ones registered during non-pregnant or postpartum periods [27]. Even with no deaths recorded, it is known that sepsis recovery does not imply superior quality of life since nearly 40% of non-obstetric patients will require complementary assistance after a sepsis event and this evaluation has not been performed in the obstetric population [28].

It was also verified that maternal age and nulliparity were factors related to morbidity progression to maternal sepsis [6,24] or ICU transfer secondary to acute pyelonephritis [29] and that cases were more often seen during 2nd or 3rd pregnancy trimesters [16,26,30,31]. This was also the most common pregnancy period found in the ICU admission group [24,29]. Low frequency of prior comorbidities is expected in young women and the history of acute pyelonephritis was similar to previous studies [4,17,29].

The use of variables able to estimate organ compromise is recommended to investigate progressive maternal morbidity [19,32] including parameters related to cardiovascular, respiratory, renal and neurologic functions in sepsis cases [33]. The record of such variables as near as possible to the critical deterioration moment would make it possible to infer prediction of ICU admission [19].

Maternal temperature is an important variable to be analyzed once it is not influenced by pregnancy and puerperal physiology modifications that could overlap suspected sepsis criteria [34]. Fever is known to be one of the elements used to determine acute pyelonephritis, frequently seen during early infection [8,26]. Low frequency of abnormal axillary temperature was expected in the improvement in ward group; in the ICU admission group the low frequency of altered temperature indicates that temperature registry alone may not be a reliable marker of severe morbidity progression [34]. Parameters of axillary temperature  $<36^{\circ}\text{C}$  or  $\geq 38^{\circ}\text{C}$ , defined as suspicious of severity disease, were inadequate to identify severe maternal morbidity in the studied sample.

Hypotension and hemodynamic instability are early events observed during sepsis [25,28]. Both groups were similar in SBP, DBP and MAP means.

Systolic blood pressure means for both groups were close to SBP criterium  $\leq 100\text{mmHg}$  from MEOWS [11], EMIP [15] and qSOFA [21], which makes this cutoff point unsuitable to investigate ICU admission in the sample studied. However, significant difference was observed by applying the cutoff value of SBP  $\leq 90\text{mmHg}$  from SOS [18], which holds SBP  $< 90\text{mmHg}$  criterium from MEOWS [11], IMEWS [13], MOEWS [19], omqSOFA [20] and MEWC [22], thus turning this parameter into a possible marker to identify severe morbidity progression. Even with noted association to ICU admission, systolic blood pressure  $\leq 90\text{mmHg}$  was observed in only 40% of ICU cases and should not be sought as a single parameter of early triage.

There was tendency to significance between groups means regarding DBP, with DBP  $< 50\text{mmHg}$ , the cutoff value from IMEWS [13], seen in a small fraction of cases admitted to the ICU. Nevertheless, this criterium could be used as an adjuvant for tracking morbidity progression in the studied cases once it resulted in OR for ICU admission inferior only to OR found for HR  $\geq 100\text{bpm}$ .

Mean arterial pressure can be used to determine sepsis induced hypotension [25] and significant difference was observed between the studied groups when the cutoff point of MAP <70mmHg from the omSOFA score [20] was tested with 45% frequency in the ICU admission group. Regardless offering the lowest OR for UCI admission in this sample, it could be used as an adjunct element to research morbidity progression considering its frequency, higher than the solely evaluation of SBP or DBP.

Even though maternal tachycardia is physiologically expected indexes over 100bpm during infections correlate to worse disease scenarios [18,25]. Irrespectively sepsis etiology, maternal heart rate over 110bpm may be found [8], as seen in the ICU admission group. Despite not being part the qSOFA score [21], which to date is applied to general population to identify cases at higher risk of clinical deterioration secondary to infection, there was 85% frequency of HR  $\geq$ 100bpm in the ICU admission group.

It is expected maternal tachycardia in association to fever status during acute pyelonephritis [31]; even so, it calls for attention the low frequency of abnormal axillar temperature in contrast to the high frequency of tachycardia in the ICU group. There was significant difference between groups with regards of HR means, reinforcing its applicability in severe maternal morbidity recognition in studied sample. Between groups there was significant difference when the HR  $\geq$ 100bpm parameter from MEOWS [11], IMEWS [13] and EMIP [15] was tested, resulting the most relevant OR for ICU admission in this sample.

Respiratory rate is a sensitive feature of physiologic balance [11] and maternal warning scores emphasize its importance as a severe morbidity marker [19]. Respiratory rate mean of the ICU admission group lies within the cutoff value of RR  $\geq$ 25bpm from IMEWS [13], MEWT [14], SOS [18], MOEWS [19] and omqSOFA [20]. Difference between groups was observed in means as well as when the cutoff point of RR  $\geq$ 22bpm from qSOFA score [21] was considered and with 65% frequency in the ICU admission group, with one of the most relevant OR for UCI admission in the studied cases.

Arterial oxygen saturation frequently is used in warning systems to predict ICU admission, and peripheral oxygen saturation (SpO<sub>2</sub>) is a suitable surrogate to this purpose [19]. Oxygen saturation above 95% is estimated to allow fetal well-being within gestational physiology and this was the observed mean in the improvement in ward group [9]. Significant difference between groups was found with regards to SpO<sub>2</sub> means and under the cutoff points determined by IMEWS and MOEWS algorithms [13,19].

This parameter was abnormal in 75% of the ICU admission cases, the most prevalent one along with HR  $\geq$ 100bpm and RR  $\geq$ 22bpm; cases were more likely admitted to ICU with abnormal SpO<sub>2</sub> than with SBP and MAP abnormalities. There is a chance that these findings may have been influenced by the large number of absent data in the improvement in ward group but considering that it is a simple obtained element and the high frequency in the ICU group this parameter could be appropriate to severe maternal morbidity screening.

Altered mental status during sepsis is an infrequently seen [28], described in 8% of maternal sepsis cases in the United States [34]. Despite the low frequency, it translates high mortality risk [28] and is described in 80% of septic shock patients [4] which makes it part of several warning systems for severe morbidity investigation [11,13,14,19-22]. That said, it is understandable that abnormal conscious level does not reflect an early organic dysfunction over the course of infection worsening and even with significant difference between groups this parameter may be inappropriate for severe maternal infection evaluation due to its low frequency [15].

Cases could be considered homogeneous with regards of initial antibiotic therapy and treatment change is expected when clinical deterioration is detected, as seen in the ICU admission group [35].

Mean hospital stay for the improvement in ward group was similar as described by other authors [16,23], who inform maternal recovery within short time span after treatment initiation [26] with mean hospital stay from 2.8 [4] to approximately 5 days [26,30]. Is it possible that the mean period of  $1.4 \pm 0.8$  days from beginning of treatment to perception of clinical worsening in the ICU admission group reflects the insidious progression of maternal morbidity [25]. Treatment protocol applied by the initial admission facility anticipates that hospital discharge should be granted once the patient remains afebrile for at least 24 hours and preferably after uroculture results. Therefore, it can be inferred that vital parameters could have settled within shorter period than the observed mean time span in the improvement in ward group, comparably to the interval of critical deterioration perception in the ICU admission group, which makes regular monitoring important to obtain early identification of disease progression.

Maternal outcomes in the ICU admission group lead to high index of critical interventions [2]. According to literature, obstetric patients are more vulnerable to development of respiratory insufficiency compared to non-obstetric patients, especially in association to acute pyelonephritis [33]. Mechanic ventilation was the most common intervention, with rate that is consonant to literature, reaffirming respiratory pattern as a morbidity progression alert [4,16,31].

The abnormal physiologic variables most frequently associated to ICU admission were HR, RR and SpO<sub>2</sub>, while parameters of HR  $\geq 100$ bpm, DBP  $< 50$ mmHg and RR  $\geq 22$ bpm were linked to the highest odds ratio. These findings suggests that vital data could be used as a method of severe maternal morbidity evaluation due to acute pyelonephritis. Implementation of vital criteria is feasible during regular maternal care practice since it requires easy access to equipment and does not demand extra training for the assistance teams [36]. As a screening tool for such cases, taking into consideration the dynamic nature of sepsis and that a single abnormality may reflect an incorrect measurement, frequent monitoring is necessary to minimize false-positive and false-negative alarms [34,22]. Additional investigation may provide refinement to cutoff values, so to avoid system fatigue on daily basis use [36].

Despite limitations regarding the retrospective design, restriction to study of cases effectively committed to ICU and specific demographic features, which may restrain applicability of the results to other populations, research findings describe a preliminary profile and potentially substantiate further studies aiming an optimized management of acute pyelonephritis and, by inference, of maternal sepsis.

Specifying clinical criteria may aid decisions from health assistance teams to either transfer patients to intensive care or to act before severe health deterioration, anticipating the lack of ICU facilities and performing towards the best outcome for these cases.

## Conclusion

Clinically recognizable maternal vital elements in acute pyelonephritis cases may help distinguish probability between progression to recovery without complications or severe maternal morbidity. Parameters of HR  $\geq 100$  beats per minute, RR  $\geq 22$  breaths per minute and SpO<sub>2</sub>  $< 96\%$  or need of oxygen supplement to maintain saturation  $\geq 96\%$  were the most frequent in ICU admitted cases and criteria of HR  $\geq 100$  beats per minute, DBP  $< 50$ mmHg and RR  $\geq 22$  breaths per minute presented higher association to this outcome.

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