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**Comparaison du Taux d'accueil au score CEDOCS pour évaluer la
surcharge dans les Services d'Accueil des Urgences d'Indre et Loire**

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Comparaison du Taux d'Accueil au score CEDOCS pour évaluer la surcharge dans les Services d'Accueil des Urgences d'Indre et Loire

RESUME

Introduction : La surcharge dans les services d'accueil des urgences (SAU) est un problème mondial majeur, entraînant des conséquences négatives telles qu'une augmentation de la morbidité et de la mortalité des patients, une diminution de la qualité des soins, et des taux plus élevés d'épuisement chez les professionnels de santé. Il existe deux principaux outils pour mesurer la surcharge dans les SAU. Le taux d'accueil (TA), un indicateur de tension indépendant européen (ITI), et le score CEDOCS, une mesure américaine de la surcharge. Cette étude vise à comparer l'efficacité de ces outils en utilisant une évaluation du ressenti de charge de travail (RCT) dans les SAU d'un département français.

Méthodes : Les données ont été collectées du 15 au 28 mai 2023 dans trois hôpitaux : un centre hospitalier universitaire (CHU) et deux hôpitaux périphériques (HP). Le nombre de patients, les évaluations de la charge de travail et les scores de surcharge ont été recueillis de manière biquotidienne. Le coefficient de Spearman a été utilisé pour évaluer les corrélations entre le ressenti de charge de travail (RCT) et les scores TA et CEDOCS. La transformation de Fisher Z a été utilisée pour comparer ces corrélations. Des comparaisons ont également été faites en fonction du type de centre, du moment de la journée et des niveaux de charge de travail perçue.

Résultats : Un seuil pour le TA a été déterminé afin de catégoriser la surcharge en trois niveaux. La corrélation entre le TA et le RCT était de 0,744, tandis que la corrélation entre le CEDOCS et le RCT était de 0,471, avec un test de Fisher révélant une différence significative ($p < 0,05$). Cette tendance s'est confirmée selon les moments de la journée et les niveaux de charge de travail. Le CR a été classé en trois catégories de surcharge avec des seuils définis comme suit : faible ($< 20\%$), modéré ($20-30\%$) et élevé ($> 30\%$). Les valeurs médianes du CR associées à chaque niveau de surcharge étaient respectivement de 18% , 26% et 35% .

Conclusions : Nous démontrons que le TA est plus efficace que le CEDOCS pour évaluer la surcharge dans les SAU, en particulier lorsque le niveau de charge de travail est élevé. Le TA permet des comparaisons plus précises entre différents SAU, offrant ainsi une mesure fiable et reproductible de la surcharge.

Mots clés : Indicateur de tension, services d'accueil des urgences, Taux d'Accueil, CEDOCS.

Comparison of the Census Rate with the CEDOCS score to assess crowding in the Indre et Loire Emergency Department.

ABSTRACT

Background: Emergency department (ED) crowding is a significant global issue, leading to adverse outcomes such as increased patient morbidity and mortality, reduced quality of care, and higher rates of burnout among healthcare professionals. There are two primary tools for measuring ED crowding. The Census Rate (CR), a European Independent Tension Indicator (ITI), and the CEDOCS score, an American crowding measure. This study aims to compare the effectiveness of these tools using a staff workload assessment (SWA) in EDs across a French department.

Methods: Data were collected from May 15 to May 28, 2023, across three hospitals: one university hospital (UH) and two peripheral hospitals (PH). The study recorded bi-daily data on patient numbers, workload assessments, and crowding scores. Spearman's coefficient was used to evaluate the correlations between SWA and both CR and CEDOCS. Fisher Z-transformation was used to compare both correlations. Comparisons were also made based on the type of center, time of day, and perceived workload levels. A threshold for CR was determined to categorize crowding into three levels.

Results: The correlation between CR and SWA was 0.744, and the correlation between CEDOCS and SWA was 0.471, with a Fisher test revealing a significant difference ($p < 0.05$). This trend was consistent across times of day, and workload levels. CR was classified into three crowding categories with thresholds defined as follows: Low ($< 20\%$), Moderate (20–30%), and High ($> 30\%$). The median values for CR associated with each crowding level were 18%, 26%, and 35%, respectively.

Conclusion: The CR was found to be more effective than CEDOCS in evaluating ED crowding, particularly when the ED has a high workload level. The CR allows for more accurate comparisons across different EDs, providing a reliable and reproducible measure of crowding.

Key words: tension indicator, emergency departments, CEDOCS, Census Rate

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SERMENT D'HIPPOCRATE

En présence des enseignants et enseignantes

de cette Faculté,
de mes chers condisciples
et selon la tradition d'Hippocrate,
je promets et je jure d'être fidèle aux lois de l'honneur et de la probité dans
l'exercice de la Médecine.

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List of abbreviations :

CEDOCS: Community Emergency Department Overcrowding Score

CR: Census Rate

ED: Emergency Department

EDWIN: Emergency Department Work INdex

ESI: Emergency Severity Index

ITI: Independent Tension Indicators

mSEAL: Modified Skåne Emergency Department Assessment of Patient Load

NEDOCS: National Emergency Department Overcrowding Score

OR: Occupancy Rate

PH : Peripheral Hospital

Rs : Spearman's rank correlation

SWA: Staff's Overload Assessments

UH: University Hospital

Table of contents

I. INTRODUCTION:	13
II. METHODS:	14
A. STUDY DESIGN	14
B. DATA COLLECTION	14
C. CEDOCS AND CR CALCULATION	15
D. INCLUSION AND EXCLUSION CRITERIA	15
E. ETHIC	15
F. STATISTICAL ANALYSIS	15
III. RESULTS:	16
A. DESCRIPTIVE ANALYSES:	16
B. PRIMARY ANALYSIS:	17
C. SECONDARY ANALYSIS:	17
IV. DISCUSSIONS:	24
V. CONCLUSION:	25
VI. BIBLIOGRAPHIE :	25

I. Introduction:

For several decades and in many countries, Emergency Departments (EDs) have been facing a crowding problem. ED crowding refers to a situation in which patient care needs exceed the department's capacity or available resources [1-4]. The causes of crowding are multifactorial and can be categorized into three areas: input crowding, corresponding to ED admissions; throughput crowding, relating to patient waiting times within the ED; and output crowding, related to the availability of hospital beds [5]. The consequences of crowding include a reduction in the quality of care [6-7-8], an increase in the number of patients leaving without being seen [9-10], and a rise in morbidity and mortality [11-17]. Crowding also impacts healthcare staff, leading to burnout, reduced working hours, and resignations [18-21]. Many tools have been developed to measure crowding in a simple and reproducible way [22]. There are two main approaches to measuring crowding: through the creation of scoring systems, as seen in the United States, or through the development of Independent Tension Indicators (ITIs), as is common in Europe. The NEDOCS (National Emergency Department OverCrowding Study) is the most widely studied in the literature [22, 23]. It has the advantage of providing a scale for grading crowding, and the different levels of crowding are comparable across various EDs [22]. However, the inclusion of variables such as the number of patients on mechanical ventilation in the ED makes this score difficult to apply outside the United States [24, 25, 26]. The CEDOCS (Community ED Overcrowding Scale) was developed in 2014 to measure overcrowding in any public ED handling at least 18,000 annual visits [27]. This score is better suited to EDs in European facilities but has been much less studied compared to other scores [24]. Moreover, it has not been assessed in EDs with fewer than 18,000 annual visits. The Occupancy Rate (OR) is the most studied Independent Tension Indicator (ITI) in the literature [22]. OR corresponds to the number of patients present in the ED divided by the number of available treatment beds within the ED. Studies show that OR is a reliable ITI and performs as

well as scoring systems in measuring overload [17, 22, 28, 29]. However, OR has the disadvantage of having a crowding threshold that depends on the ED's activity and lacks a scale to grade this crowding [24]. Therefore, ITIs neither allow to compare crowding between different EDs nor to grade crowding. The Census Rate (CR) is a new ITI created in Sweden in 2022 [29]. It corresponds to the number of patients present divided by the average daily number of ED visits. CR has the advantage of being comparable across different EDs. No other studies have analyzed this ITI.

The objective of our study is to compare the effectiveness of the CEDOCS and CR as tools for evaluating crowding in different EDs within the same region.

II. Methods:

A. Study design

The study was conducted prospectively from May 15 to May 28, 2023 across three hospitals in the same region: one university hospital (UH) and two peripheral hospitals (PH).

B. Data collection

Data were collected on the number of ED visits from 2017 to 2022 and the number of treatment beds in advance. A designated staff member in each department manually collected the Staff's Workload assessment (SWA) on a numerical scale from 1 to 6, with 1 representing the calmest possible day and 6 the most overcrowded day. Additionally, they recorded the number of patients present, the number of patients with an ESI triage level of 1 and 2 (ESI 1 = critically ill, unstable patients; ESI 2 = potentially unstable patients), the number of unseen patients, and the longest length of stay in hours. These variables were collected twice daily: between 9:00 and 10:00 am and between 5:00 and 6:00 pm.

C. CEDOCS and CR calculation

CEDOCS was calculated using the MDcalc.com website [30]. The score ranges from 1 to 200 and is divided into six categories reflecting the level of crowding: level 1 (score of 1 to 20) = not busy, level 2 (score of 21 to 60) = busy, level 3 (score of 61 to 100) = very busy but not overcrowded, level 4 (score of 101 to 140) = overcrowded, level 5 (score of 141 to 180) = severely overcrowded, and level 6 (score of 181 to 200) = dangerously overcrowded [27].

TA is calculated by dividing the number of patients present by the annual average daily visits.

D. Inclusion and exclusion criteria

The included criteria were senior physicians and nurses who agreed to participate in the study.

The excluded criteria were junior physicians, medical residents, medical students, and people who refused to participate, healthcare staff from the Short-Stay Units.

E. Ethic

The study is outside of the Jardé law, and we have not sought the consent of a regional ethics committee. It will be requested in order to submit the article to the Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine.

F. Statistical analysis

A Shapiro-Wilk test was performed which showed that all three assessment tools don't follow a normal distribution, justifying the use of a non-parametric test. A Spearman's rank correlation (R_s) was performed between the CEDOCS and SWA, and then between CR and SWA. The interpretation can be divided into five categories: between 0 and 0.1 = negligible; between 0.1 and 0.3 = weak; between 0.3 and 0.5 = moderate; between 0.5 and 0.7 = high; between 0.7 and 1 = very high [31]. Both correlations were compared with Fisher's Z-transformation with a significance threshold of $p < 0.05$.

A Spearman's rank correlation (R_s) was performed by type of center (UH and PH), by time of day (day and night), and by SWA level (< 3 or ≥ 3). Correlation comparisons were made without statistical test.

The CR was categorized according to the level of crowding: Low, including CR values below the 33rd percentile. Moderate, including values between the 33rd and 66th percentiles. High, including values above the 66th percentile. The distribution is represented by stacked density curves in a Ridgeline Plot.

All data were collected in Excel, and statistical analyses were conducted using R software.

III. Results:

A. Descriptive analyses:

It was initially planned to collect a total of 813 data points. The number of data collected were 760 due to the miss of 53 data points. No data were lost at the UH, 32 are missing at PH 1 (20 due to loss of papers, 19 due to refusal to answer, 12 due to out-of-hospital team departure) and 2 were lost at PH 2. The UH receives an average of 49,381 visits per year with a treatment bed capacity of 39. The two PH receive an average of 16,058 and 12,497 visits per year, with a treatment bed capacity of 12 and 8, respectively [Table 1].

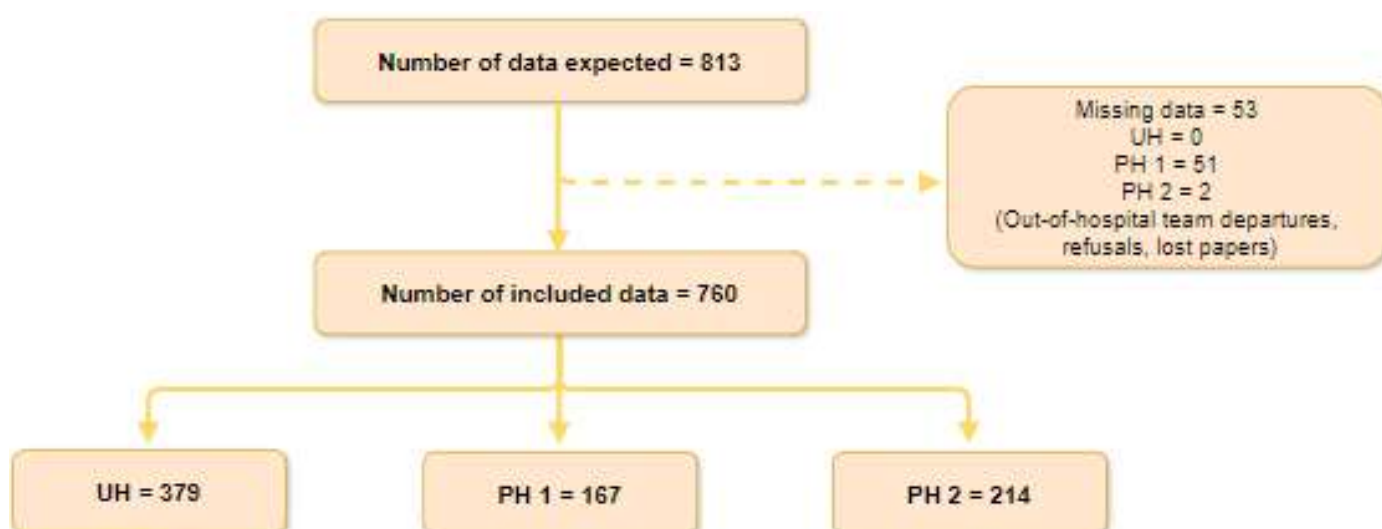


Figure 1. Flow chart

UH : University Hospital, *PH* : Peripheral Hospital

The UH has a mean CEDOCS of 104.5, a mean CR of 0.27, and a mean SWA of 2.6. PH 1 has a mean CEDOCS of 44.2, a mean CR of 0.28, and a mean SWA of 3.2. PH 2 has a mean CEDOCS of 28.7, a mean CR of 0.19, and a mean SWA of 2.4 [Table 1]. There are significant differences between the SWA, CR, and CEDOCS for each hospital after performing a Kruskal-Wallis test [Table 1].

Table 1. Characteristics of included study sites

	Universitary hospital	Periphéral hospital 1	Peripheral hospital 2	p-value
Annual visits average	49 381	16 058	12 497	
Number of treatment beds	39	12	8	
Census rate average	0,268998053	0,275383945	0,192974885	< 0,001
CEDOCS average	104,5	44,19230769	28,67857143	< 0,001
SWA average	2,581078644	3,1976	2,392592593	< 0,001
Number of schedules not included due to missing data	0	2	1	
SWA scale				
< 3	19	12	20	
≥ 3	9	14	7	

CEDOCS : Community Emergency Department Overcrowding Score. SWA : Staff's Workload Assessment.

B. Primary analysis:

The correlation between CR and SWA is 0.744, and the correlation between CEDOCS and SWA is 0.471 [Figure 2]. The comparison of the two correlations yielded a Fisher Z score of 2.801573 with $p < 0.01$.

C. Secondary analysis:

Regarding comparison by hospital type: for the UH, the correlation between the CR and SWA is 0.835, and the correlation between the CEDOCS and SWA is 0.735 [Figure 3a]. For the PH, the correlation between the CR and SWA is 0.766, and the correlation between the CEDOCS and SWA is 0.768 [Figure 3b].

Regarding comparison by time of day: For CR, the correlation with the SWA is 0.696 during the day and 0.805 at night [Figure 4b]. For CEDOCS, the correlation with the SWA is 0.379 during the day and 0.576 at night [Figure 4a]. "

Regarding comparison based on SWA level: The correlation between the CR and the SWA is 0.637 when the SWA is below 3 and 0.209 when it is greater than or equal to 3 [Figure 5b]. The correlation between CEDOCS and SWA is 0.473 when SWA is below 3 and -0.159 when it is greater than or equal to 3 [Figure 5a].

For categorization of CR into three levels. The medians values for Low crowding is a CR at 18% with the range [$< 20\%$] . The medians values for Moderate crowding is a CR at 26% with the range [20% : 30%]. The medians values for High crowding is a CR at 35% with the range [30% : 60%] [Figure 6].

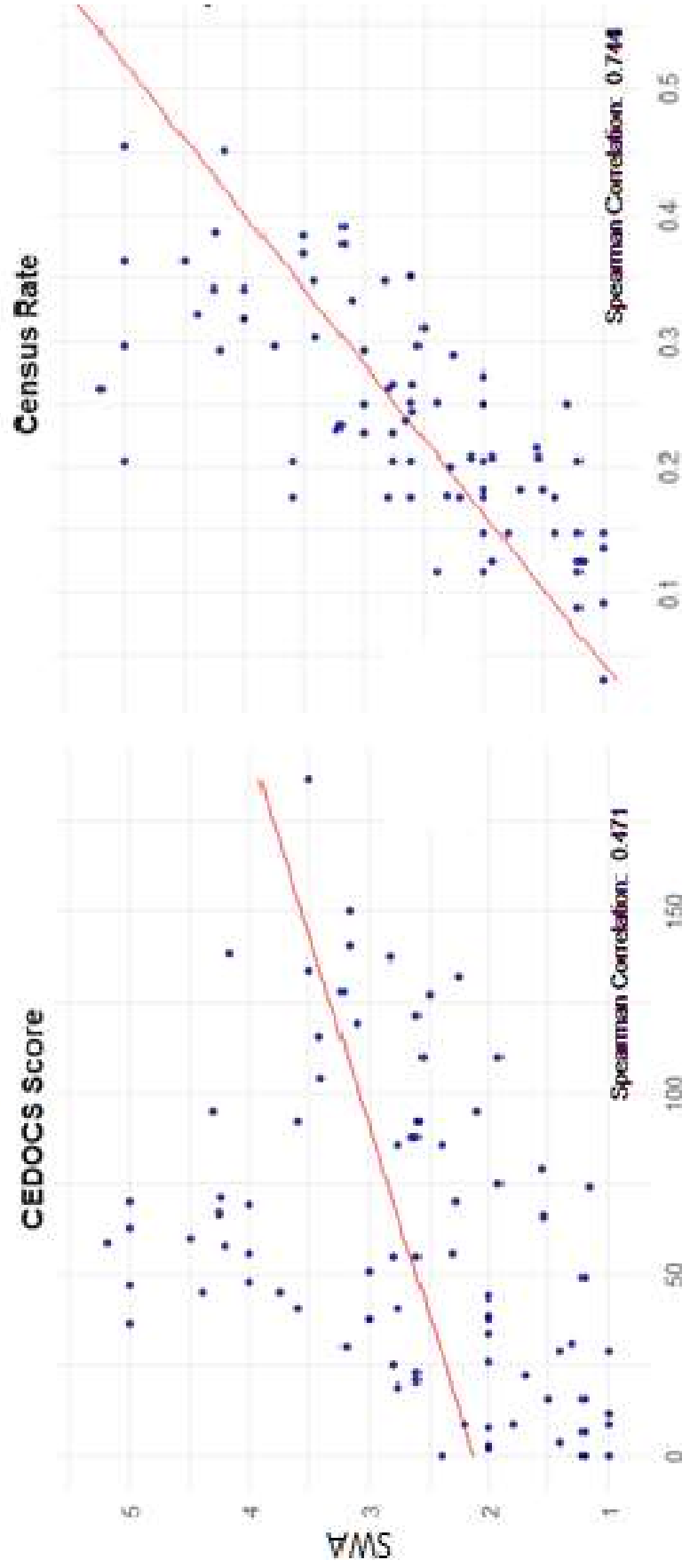


Figure 2a. Relationship between CEDOCS score and SWA **Figure 2b. Relationship between CR and SWA**

Figure 2. Relation between SWA and measuring tools

CEDOCS : Community Emergency Department OverCrowding Scale.SWA : Staff : Workload Assessment.

CR : Census Rate

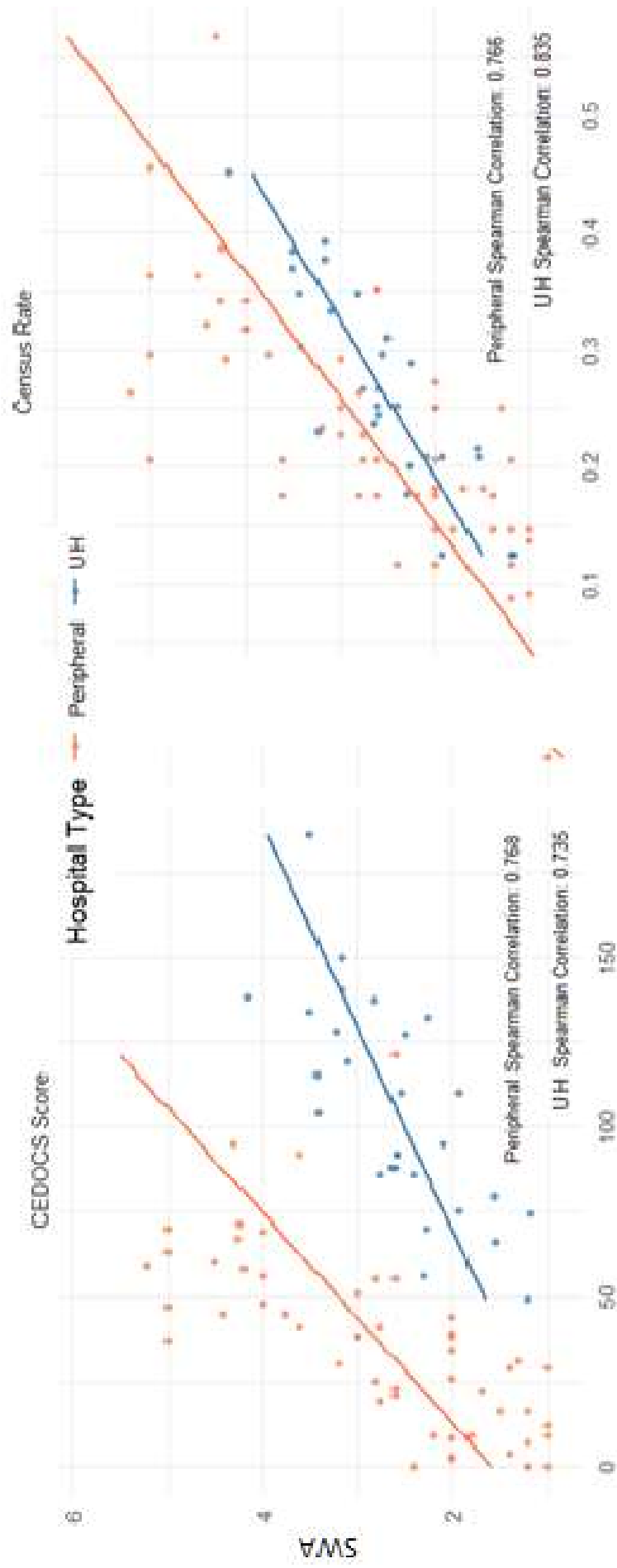


Figure 3a. Relationship between CEDOCS score and SWA by hospital type

Figure 3b. Relationship between CR and SWA by hospital type

Figure 3. Relationship between SWA and measuring tools by hospital type

CEDOCS : Community Emergency Department OverCrowding Scale. CR: Census Rate. SWA: Staff's Workload Assessment. UH : University Hospital.

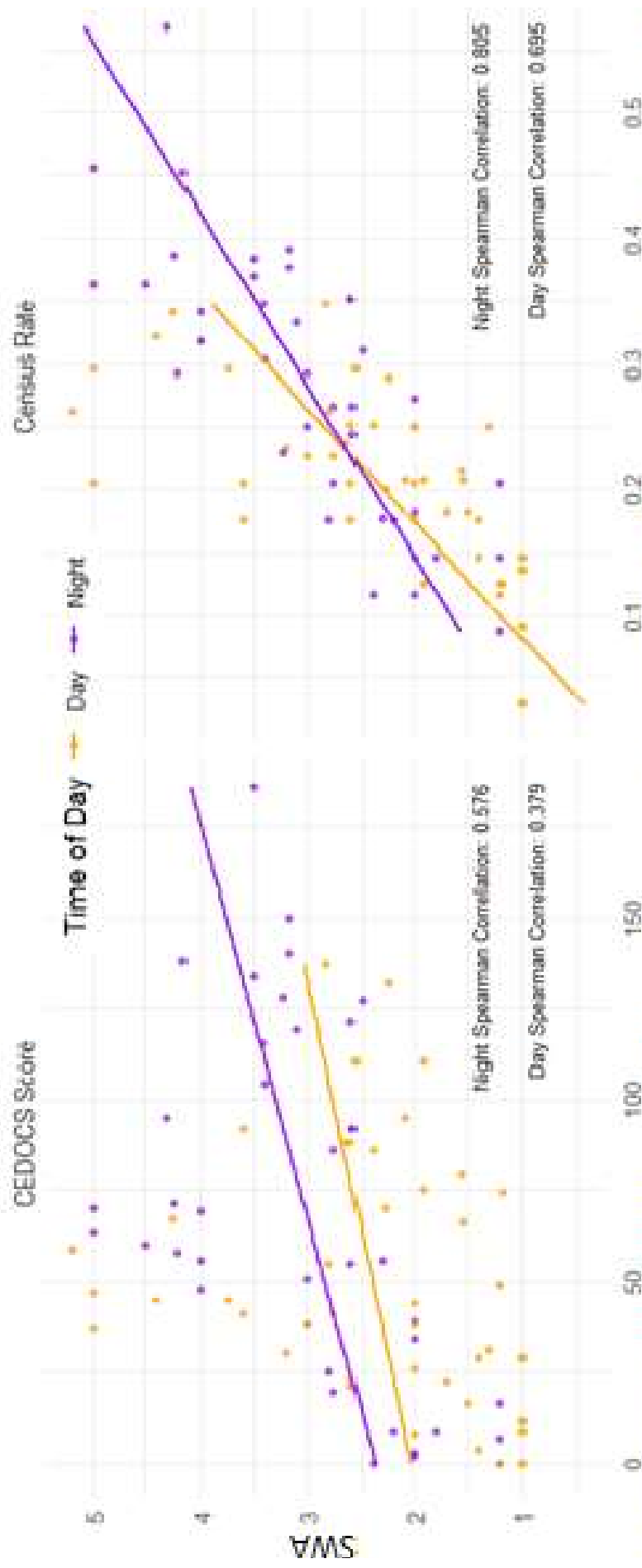


Figure 4a. Relationship between CEDOCS score and SWA by time of day

Figure 4b. Relationship between CR and SWA by time of day

Figure 4. Relationship between SWA and measuring tools by time of day

CEDOCS : Community Emergency Department Overcrowding Scale. CR : Census Rate. SWA : Staff's Workload Assessment.

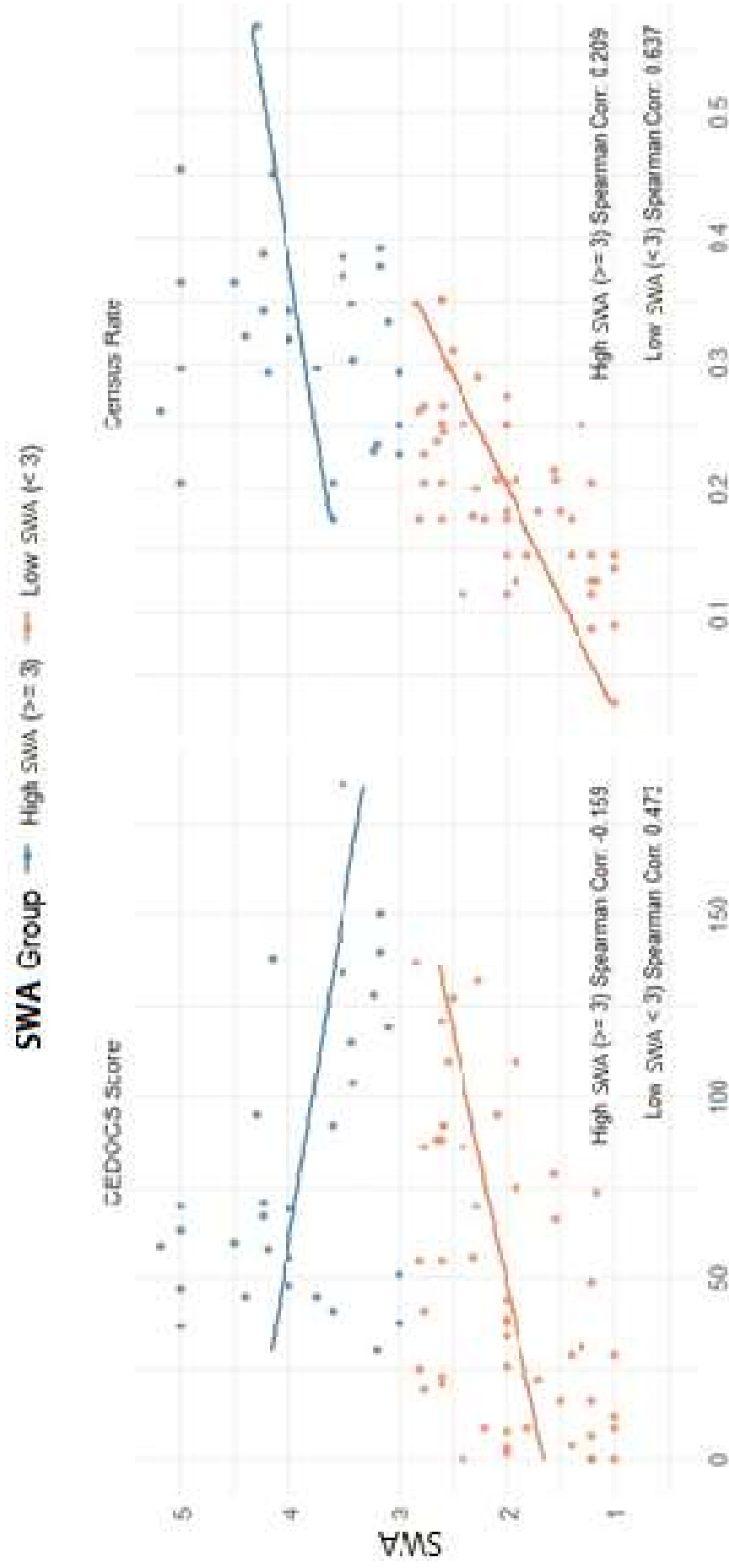


Figure 5a. Relationship between CEDOCs score and SWA by SWA level **Figure 5b. Relationship between CR and SWA by SWA level**

Figure 5. Relationship between SWA and measuring tools by SWA level

CEDOCs: Community Emergency Department Overcrowding Scale. CR: Census Rate. SWA: Staff's Workload Assessment.

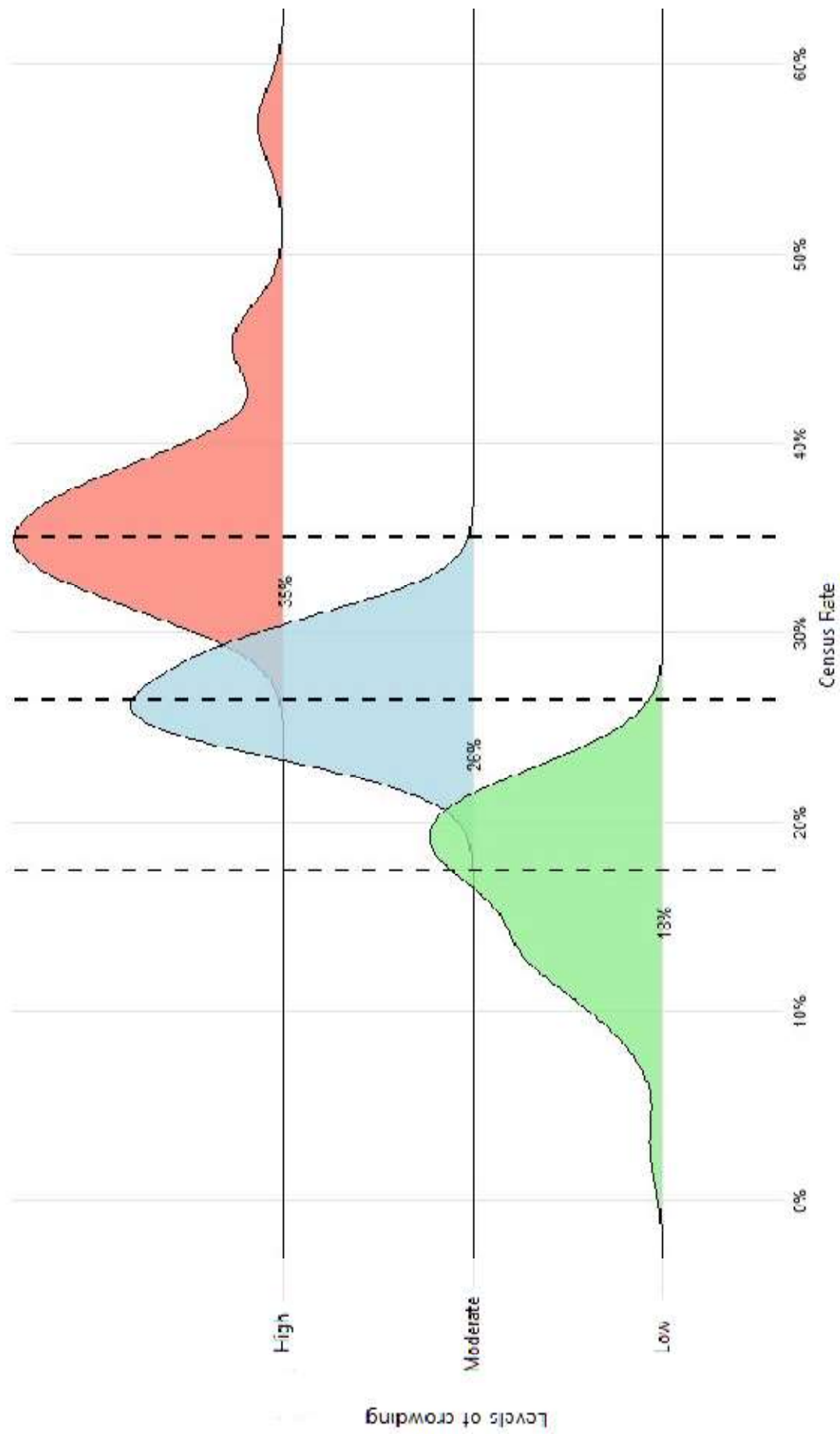


Figure 6. Classification of CR in 3 levels of crowding

IV. Discussions:

In this study, it was found significantly that CR correlates better with the SWA than CEDOCS. Moreover, the correlation between the CR and SWA remains stronger across different times of the day. Finally, CR shows a better correlation with SWA when crowding is high. These results suggest that CR is a more effective tool than CEDOCS for assessing and comparing crowding across different EDs.

It was also demonstrated that it is possible to divide CR into distinct categories, which could allow to define crowding based on CR levels in the future.

This is one of the few studies focusing on crowding in modestly sized peripheral centers. The literature supports that the SWA is effective in assessing emergency department workload [32; 33]. CEDOCS was previously studied in the UH of Indre-et-Loire during a longer-term study, which found a mean CEDOCS of 106.2, a result like that found in our study [34]. A 2022 study examining the relationship between the SWA and CR found a correlation of 0.75, also close to our findings [29]. Our choice to compare crowding scores with SWA is justified by the demonstrated negative effects of crowding on healthcare personnel [18-21]. This approach also engages professionals in the study and ensures that their perspectives are considered. Finally, to our knowledge, this is the only study that attempts to establish guidelines for interpreting the CR.

We chose to include only registered nurses and senior physicians. Including students or junior physicians could introduce a selection bias, as this group may feel crowded more quickly due to a lack of experience. Additionally, the distribution of junior doctors is uneven across regions, with their absence in PH, which could bias the comparability between centers.

This study has several strengths. It is a multicenter prospective study. The data collection period includes a variety of days, such as weekdays, weekends, and public holidays. Moreover, the study presents a low amount of missing data, which is mainly due to out-of-hospital team departure in PH, lost data collection forms, and refusals to participate.

However, this study has several limitations. The short study duration does not allow for exploration of climatic, epidemic, and calendar variations [34; 35]. Secondly, the lack of validation in the literature for the use of CEDOCS in centers receiving fewer than 18,881 patients annually [27] - a condition not met by the two PH [Table 1] - is a limitation to the significance of our study. We chose to collect data at two different times of the day, avoiding

shift changes. This may limit the evaluation of the score throughout the day. The literature suggests that the interval between two workload assessments should be 4 hours for accurate evaluation [36]. Collecting data more frequently seems challenging in a context of crowding.

V. Conclusion:

CR is a reliable, easily collected, and reproducible indicator that allows to compare crowding across EDs with different activity levels. Further studies are needed to confirm our results and to establish crowding scale for CR.

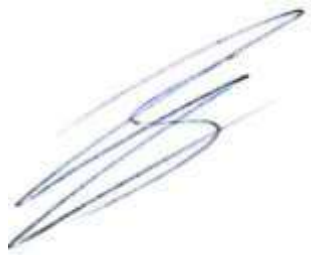
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Vu, le Directeur de Thèse

A handwritten signature in blue ink, consisting of several fluid, overlapping strokes that form a stylized, elongated shape.

Vu, le Doyen
De la Faculté de Médecine de Tours
Tours, le

HAMAIDE Jonathan

29 pages – 1 tableau – 6 figures

Résumé :

Cette étude a pour objectif de comparer deux outils d'évaluation de la surcharge, le Taux d'accueil (TA) et le score CEDOCS. Nous avons pour cela comparé leur corrélation avec une échelle de ressenti de surcharge (RCT) par le personnel hospitalier déjà validée en Indre et Loire. L'étude s'est déroulée dans un hôpital universitaire et deux hôpitaux périphériques d'Indre et Loire du 15 au 28 mai 2023. Nous avons calculé les corrélations à l'aide du coefficient de Spearman et les avons comparées grâce à une transformation Z de Fisher.

La corrélation entre le TA et le RCT était de 0,744, tandis que la corrélation entre le CEDOCS et le RCT était de 0,471, avec un test de Fisher révélant une différence significative ($p < 0,05$). Cette tendance s'est confirmée selon les moments de la journée et les niveaux de charge de travail. Le CR a été classé en trois catégories de surcharge avec des seuils définis comme suit : faible ($< 20\%$), modéré ($20-30\%$) et élevé ($> 30\%$). Les valeurs médianes du CR associées à chaque niveau de surcharge étaient respectivement de 18% , 26% et 35% .

La corrélation entre le TA et le Taux d'accueil est meilleure que celle du score CEDOCS de manière significative. Sur les analyses secondaires, le TA a une meilleure corrélation avec le RCT notamment au sein du CHU et une corrélation plus homogène tout au long de la journée, notamment en situation de forte surcharge. Le TA est l'outil le plus pertinent pour mesurer et comparer la surcharge au sein des SAU d'Indre et Loire.

Mots clés : Indicateur de tension , services d'accueil des urgences, Taux d'Accueil, CEDOCS.

Jury :

Président du Jury : Professeur Fabien ESPITALIER

Directeur de thèse : Docteur Frédéric PARIS

Membres du Jury : Docteur Thomas MOUMNEH

Docteur Pierre DENAUD

Date de soutenance : 28 octobre 2024