Which indicators to include in a crowding scale for Emergency Department ? A national French Delphi study as the item generation step.

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SUMMARY

Background: ED crowding is a serious international public health issue with a negative impact on quality of care. Despite 2 decades of research, there is no consensus regarding indicators used to quantify crowding. The objective of our study was to select the most acurate ED crowding indicators. **Material and methods:** Delphi method was used. Selected indicators originated from a literature review and propositions from FEDORU workgroup. Selected national experts were emergency physicians with a special interest in ED crowding. They had to assess each indicator in term of validity, out of a Likert scale from 1 to 9. Indicators withdrawal criteria after each round (consensus) were over 70% of answers ≥ 7 with IQR < 3 (positive consensus) or over 70% of answers ≤ 4 and IQR < 3 (negative consensus). Study stop criterion was based on answers stability between the tours. **Results:** 41 experts answered the first round (89.13%) and 37 the second (80.43%). Among the 57 included indicators, 15 reached consensus: 4 input indicators, 6 throughput and 5 output ones. For those 3 categories ≥ 7 answers rate were respectively 80.9%, 76.9% and 75.0%. Five indicators were deducible from the mandatory Emergency Department Discharge Summary (EDDS). They obtained 80.2% of ≥ 7 answers. **Conclusion:** Our study results allow building and validating a crowding measuring tool from indicators approved by experts. It is necessary to further reflect about ED crowding as a concept and what is expected from a complex score.

Background.

Crowding in emergency department (ED) is an increasing public health problem [1-2]. Several reviews have described this topic [1, 3-6]. Crowding is associated with a decrease in patient's satisfaction [7], an increase of patients leaving without being seen [8-11], an increase in medical errors [12] and i*n fine* with a lower quality of care and an increase in mortality for inpatients [13].

The main goal of a crowding scale is to be a tool helping emergency physicians, hospital directors and health authorities to identify, manage and forecast crowded periods. Despite 2 decades of research, there is no consensus regarding indicators used to quantify crowding. A recent review identified 71 crowding indicators [6]. These indicators were conceptualized and classified according to the input-throughput-output model proposed by Asplin [14].

Since 2002, almost 7 composite scales were proposed [15-20]. The main limitation of these complex scores was the lack of information provided regarding the cause of crowding (input – throughput - output). In addition, these scores, though acurate when used in their creation centres, do not usually translate well elsewhere [21-22].

In order to provide information on the causes of crowding as well as the most acurate and attractive professionally endorsed indicators, a qualitative approach was recentely considered through ICMED score [18], where Delphi method was used [23]. To date, no crowding indicator has been validated in France. The Emergency Department Discharge Summary (EDDS) [24] has been made compulsory in 2013 and real time transmission is a national objective. The currently used version, allow calculation of few crowding indicators.

The objective of our study is to select the most acurate indicators of crowding according to Emergency physicians, using the consensus Delphi method. It is the first step towards building and validating a crowding measuring tool.

Material and methods

A consensus method needs to be used when there is no evidence-based conclusion despite numerous publications. This is the case of ED crowding measures. Among those methods, Delphi was selected [25-28]. This procedure allows consulting with several geographically distant experts. They can express their opinion freely without influencing or being influenced by other group members, as answers are anonymous. Delphi method is based on administering repetitively a questionnaire to experts in a defined field. During repetions, experts are provided with previous rounds' feedback. Items reaching consensus are withdrawn from the following rounds according to predefined rules including end of procedure criteria. Three method reviews of Delphi studies have been published [29-31]. They provided recommendations on using this method [29] that we have used in this study. Figure 1 illustrates our study step by step.

Objective of the study

The objective was to select indicators making consensus and reflecting acurately ED crowding. The question asked was: « According to you, what is the validity of "indicator" to reflect ED crowding? »

Indicators selection

Eligible crowding indicators were those collected within EDs. Those included here were selected from 2011 Hwang review [6] and a comprehensive Pub Med literature search between 1 January 2011 and 1 January 2015. MESH search keywords were: "emergency department" AND ("crowding" OR overcrowding). Summaries were reviewed to select indicators absent from Hwang revue [6]. Additionally, indicators suggested by the work goup « Crowded Hospitals » from the « Federation of Regional Emergency Departments

Observatory » (FEDORU). According to Asplin's model, indicators have been grouped in 3 categories: those reflecting input, throughput and output [14].

Experts' selection

Only Emergency medicine doctors working in France were eligible. Experts have to have taken part in a work group dealing with crowding. In addition, those having published on crowding in a Pub Med referenced review were also selected. The study pilot group within FEDORU has then validated the list of pre-selected experts.

First round.

The questionnaire was pre-tested on a small sample of 10 Emergency medicine doctors. For each included indicator, experts were asked to rate their adequacy using the Likert scale, out of 10 points (1 : very low validity ; 10 : excellent validity). Experts also had the opportunity to argue their answers and recommend new measures. Questionnaires were administred through Google Forms®. Answers were all anonymous, as much between experts as between experts and study coordinators.

Analysis of first round answers and withdrawal of consensual indicators

For each indicator, median, percentage of answers ≥ 7, percentage of answers ≤ 4, first quartile (Q1), third quartile (Q3) and interquartile interval (IQR) were used. Indicators were considered having recieved positive consensus when obtaining over 70% of answers ≥ 7 and IQR ≤ 2 and having received negative consensus with over 70% of answers ≤ 4 and IQR ≤ 2. Consensus indicators were withdrawn from the questionnaire on the following round. Experts' comments were qantitatively analysed and summarised.

Second round.

On the second round, the questionnaire was re-submitted to the experts who answered on the first round. For each indicator, quantitative results of the first round were given to experts. A summary of experts' comments on each indicator was provided. Consensus critera were defined likewise.

Delphi's end of procedure criteria

Study end's criteria were pre-determined according to recommendations [30-31]. Answers distribution's stability between round one and two was the deciding factor. Answers' distribution was compared using the Wilconson-Mann-Withney test. If answers' distribution was stable for all measures, a third round was then unnecessary. If not, a third round would then be organised if for at least one of the measures, the rate of answer $\geqslant 7$ was over 50%.

Results.

Out of the 53 pre selected experts, 46 agreed to participate. Among theem, 41 (89,13%) answered the first round and 37 the second (80.43% overall participation rate). Eighty three percent (83,4%) of experts had been working in an ED for over 10 years and 40.5% for over 20 years. Fourty six (46.4%) were working in a university teaching hospital.

From the afore-mentionned literature review and FEDORU group suggestions, 54 crowding indicators met inclusion criteria. There were 18 input indicators, 22 throughtput and 14 output ones.

Out of the 54 tested indicators, 9 were agreed upon on the first round (positive consensus) and were therefore withdrawn from the procedure for the following rounds. Experts made 499 comments, making it 12 comments per expert and 10 per indicator. On the second round, consensus was reached for 8 more indicators: 7 of them positive, the other negative.

Concernin the answer' stability, there was a stastically significant difference in the answers' distribution for 6 of the measures between round 1 and 2. None of them had a rate of $\geqslant 7$ answers over 50%. Delphi procedure was accordingly stopped after the 2nd round.

After both rouds, 15 indicators gained positive consensus. Four of them were input measures, 6 were throughput and 6 output. On average, $\geqslant 7$ answers rate was 77.9%. It was respectively 80.9%, 76.9% and 75.0% for output, throughput and input (table 1).

Among the 15 selected indicators, 5 were directly deductible from EDDS that allow a national achievability. Two 2 just needed some adjustment to be deductible. Regarding the 5 directly deductible indicators the average $\geqslant 7$ answers rate was 80.2%.

Discussion.

ED crowding is an international public health problem [2, 32] with hight impact on quality of care [13]. In 2005, French healthcare authorities issued recommandations on ED crowding handling through the « Hôpital en tension » report [33]. Despite several publications and literature reviews on the subject of ED crowding measuring tools, a consensus for a validated measure or complex score has yet to come [34].

Delphi method has been used in numerous fields of research including education sciences, business and healthcare. It has been applied to select healthcare systems' quality assessment tools [30, 35-36]. Regarding the field of Emergency Medicine, it has already been used to define optimal management of some conditions [37-38], to select quality measurement tools in EDs [39-40]. As for crowding, consensus methods have already been used [41] including Delphi method [23, 42].

The Delphi method approach does not guarantee a consensus in itself. Literature review highlights an often-unprecise method in some studies [29-30]. To achieve a reliable method, 4 important parameters are used to define a quality score [29]: A detailed and reproducible expert selection, criteria for exclusion of items between each round and criteria for stopping Delphi procedure. In our study, all 4 criteria were fullfilled, as was only the case in 4% of the studies [29]. In addition to these criteria, it seemed important to clearly state the question asked to experts.

A precise definition of the issue and of the question raised to the experts is key [43]. The question should be precise and should have been mentionned in previous publications. In our study, expert was asked about validity of the indicators. In Ospina study, experts were asked to rate the « importance » without giving a precise definition [42]. In Beniuk study, in the same question experts were asked if the indicators were « clear, achievable, and relevant » [23].

There is no consensus on criteria to withdraw indicators after each round [29-31] and criteria to stop the procedure. We define consensus using the agreement rate that is the most commonly found in the literature [29-30]. In 35% of Delphi studies a distribution criterion like median or IQR is associated with this criterion as we did [30]. In 70% of studies, the number of rounds planned is the only criteria used to stop the Delphi study [30]. This sole

approach provides no information on reaching a stable consensus or not. As recommended we tested answers' distribution stability for each indicator to make the decision to stop or not the processus [31].

At the end of the 2 rounds, 15 indicators received positive consensus distributed as 4 inputs, 6 thoughput and 5 output ones. Six of them belonged to the 8 indicators suggested in Beniuk [23]. In our study the number of patients leaving without beeing seen (LWBS) was not selected. Unlike in France, LWBS is used for quality of care assessment in EDs in UK [17] which would explain why it was not selected in our French study.

The main validated complex crowding measuring scores [15-20] use 6 concepts: number of patients in ED at a given time, delay before being seen, lenghth of stay, number of medical staff, number of boarding patients waiting for transfer and patients' severity. Patient's severity is the only concept not withheld in our study. In EDWIN, READI and SEAL scores, patient's severity was assessed through the severity scale collected through the orientation nurse and in NEDOCS through the number of ventilated patients (rarely available through the ED information system). According to experts, the impact of patient's severity on ED is greatly different whether there is an ICU in the same hospital than the ED. In the ICMED score [19], developed from indicators selected thanks to Delphi method, severity was not taken into account. In our study, interestingly, the number of patients over 75 years old was sustained as an indicator of the workload. The workload generated from managing over 75 years old is heavy in ED and these patients often have a long stay [44]. Nationwide data from USA showed higher crowding in the EDs receiving a higher proportion of over 65 years old [45]. In France, Carli report highlights the importance of a geriatrics pathway to ease orientation and transfers in ED [46]. An indicator built on individual workload and including admission data could be interesting and certainly more complete than the Acuity ratio previously suggested. This index can be linked to those predicting hospitalisation from admission data [47-52].

The number of patients present at a given time is almost always présent in complex indicators [15-20]. It is standardised on the number of ED beds and performs similarly to EDWIN and NEDOCS scores to predict crowding felt by ED staff [53]. These performances were similar to those of EDWIN score on predicting ambulance diversion and patients leaving without being seen [54]. It is probably the most universal indicator and easiest to collect. The patient / doctor ratio is included in READI score [16] and was elected in our study. This indicator reflects well crowding but would de complex to collect in real time.

Output crowding factors are primarily responsible for generating crowding [1,3-4,46,55-58]. In our analysis, output indicators obtained the best median response like in Delphi Ospina [42] and were put forward in a Focus group study dedicated to crowding causes [59]. In ICMED score [19] issued from a Delphi study [23], 2 indicators reflected output: boarding time and number of boarding patients. These 2 indicators were selected by experts in our study, the second gaining the highest score. End of care time in ED could be a relevant variable to add to ED information systems (EEDS in France). It would allow calculating boarding time in real time, often seen as an output indicator of overcrowding [55-58].

The development of a scale is based on 4 steps: item generation, item reduction, psychometric and construct validity and extern validity. Our study represents the first step. As for latent variables (ie: quality of life), there is no absolute gold standard of crowding. In this context of latent variables, construct and psychometric validity is a key the development of a scale. This step is missing in previous study concerning crowding. That could explain that an important number of scores has already been suggested with similar [53] but variable performances depending on context [21-22]. Using methodology from latent variable scale devlopment is probably a promising approach.

One of the main obstacle to developping a crowding score is the lack of a unique gold

standard of crowding and basically answer the question: is this ED overcrowded ? Crowding percieved by staff is the most frequently used proxy to initially build and validate the main scores [15-20]. Ambulances deviation and patients leaving without being seen are aloso used as proxy [6]. Subjectivity of crowding perception could explain why scores have a mediocre external validity when used outside the area where they were developed [21-22]. Association of crowding perception and care quality indicator (LWBS, time before ECG, patients' satisfaction) remains the most satisfying option for the evaluation of extern validity. For future crowding scale studies, those proxies of crowding have to be used only for extern validation and not for the construction of the scale. One more time, construct and psychometric validity have to be included in development crowding scales study. Additionnaly it's to use indicators automatically collected through ED information systems (the mandatory EDDS in France). Also, a multi-dimentional score is preferable to provide information layered by crowding category (input – throughput – output) as previously suggested [6].

Conclusion

Our study has a good validity as it fullfilled method quality criteria suggested in the literature. Fifteen crowding indicators reached consensus. Five of these are deductible from the mandatory French EDDS. They potentially reflect the main three sources of crowding (input – throughput – output). This item generation is the first step of the development of a crowding scale wicht has to include a psychometric and construct validity evaluation before extern validation.

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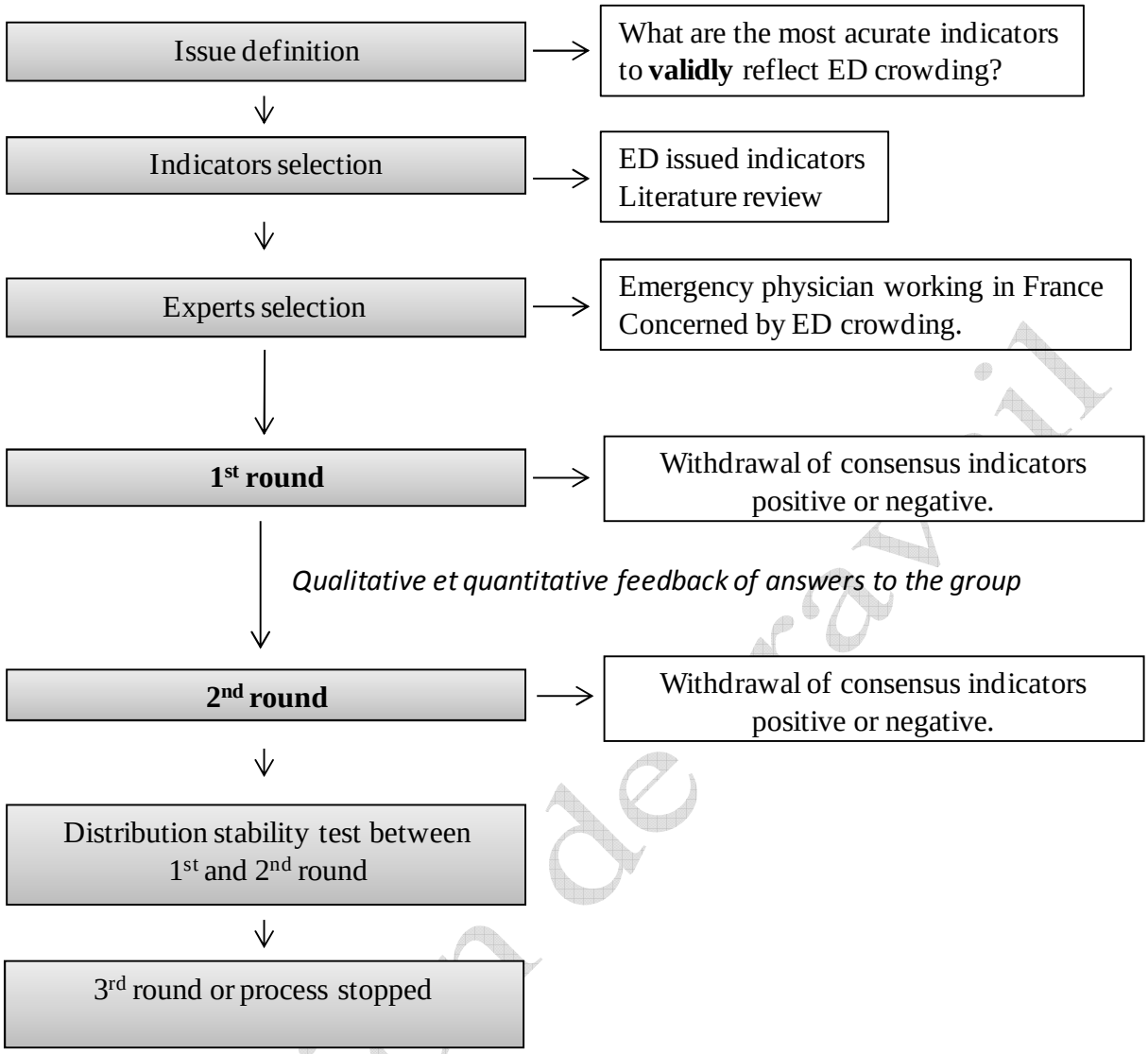

Figure 1: Chart flow of the study

Indicators	Round	Median	% ≥ 7	% ≤ 4	Q1	Q3
INPUT						
Number of admission over the past 24 hours	2	7	83,3	2,8	7	8
Number of patients not seen by triage nurse	2	7	72,2	11,1	6	8
Number of patients not seen by a doctor	2	7	72,2	2,8	6	8
Time to be seen by a doctor	2	8	72,2	5,6	6	8
Average of input indicators		*7*	*75,0*	*5,6*	*6*	*8*
THROUGHPUT						
Patients' average length of stay	2	8	83,3	0,00	7	8
Number of patients over 75 years old	2	8	80,5	2,8	7	8
Number of patients present	1	7	78,1	5,1	7	8
Number of patients per doctor	1	8	75,6	5,1	7	8
Number of patients per nurse	1	7	70,7	5,1	6	8
Number of patients on a gurney or in the corridors	1	7	73,2	7,7	6	8
Average of throughput indicators		*7*	*76,9*	*4,3*	*7*	*8*
OUTPUT						
Number of patients awaiting boarding	1	8	87,8	0,0	8	9
Number of transfers for lack of bed over the last 3 days	2	8	80,6	0,0	7	8
Average boarding time	1	8	80,5	5,1	7	9
Number of patients present in the UHCD* over 24 h.	1	8	78,1	0,0	7	8
Number of patients boarding over the last 3 days	1	8	75,6	5,1	7	8
Average of output indicators		*8*	*80,9*	*2,1*	*7*	*8*

***In bold**: Indicators deductible from the Emergency Department Discharge Summary (EDDS)*

Table 1: Selected indicators after both rounds and distribution of answers for these indicators.