Comparison between five risk assessment methods of patient handling

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ABSTRACT

Several methods currently exist to assess risks resulting from manual handling of patients, based on various perspectives and analyzing different working conditions in the health-care sector. For that reason, a comparison of the main tools properties is discussed in the current study, establishing their strengths and weaknesses in order to provide guidance for the selection of a potential ideal method to use. The comparison is done based on ten items selected from MAPO, DINO, PTAI, Care Thermometer and Dortmund Approach methods, by qualifying each one with different scores, according to a pre-determined criterion. For this purpose, a previous fieldwork was performed in various hospital wards and operating rooms of a public health service hospital, comparing the results of partial and total scores. It was observed that, although the five methods compared are similar in nature, the methodology of each them is different and, therefore, the results obtained are unequal. On one hand, it was found that MAPO, PTAI and Care Thermometer methods provide a more balanced approach on the different variables that, in a preventive level, influence the patient handling. On the other hand, it was evidenced that DINO and Dortmund Approach methods focus almost exclusively on the technical work of the caregiver and on the detailed postural analysis that determines the lumbar load, respectively. As a conclusion, we believe that it is necessary to advance with the improvement of these tools, and in this sense we propose the basic lines of a method that integrates those factors that were top rated.

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1. Introduction

Preventing musculoskeletal disorders resulting from patient handling requires accurate assessment tools to properly identify risks. Initially, some general methods of assessment, such as REBA (Hignett and McAtamney, 2000) could be used to detect risk factors or to evaluate certain transferring patient's techniques, but nowadays specific instruments are available. Although there are already numerous methods that assess such risks, which are included in related literature with several descriptive studies and validations (Battevi et al., 2006; Jager et al., 2010; Johnsson et al., 2004; Karhula et al., 2009; Steer and Knibbe, 2008), all of them have advantages and disadvantages that make them more or less appropriate in a

preventive level to treat a specific aspect of patient care. On the contrary, just a few studies are available in the current scientific literature comparing various risk assessment methods of patient handling, which are mostly focused in pointing out their similarities and differences (Tamminen-Peter et al., 2009). For this reason, the aim of this work is to compare, in the most objective way possible, the features of five assessment tools, and to determine their strengths and weaknesses in order to provide guidance for the method to be used.

2. Assessment methods selected

To perform the mentioned comparison, five of the most prominent specific methods of risk assessment of patient handling referenced in the international literature were selected, namely MAPO, DINO, PTAI, Care Thermometer and Dortmund Approach, all of which are also included in the "ISO/TR 12296:2012 Ergonomics standard. Manual handling of people in the healthcare sector". The reason underlying the selection of these five methods has been the

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different range of aspects valued by each of them, which allows to cover a wide range of study variables. These include the work organization (MAPO), the mobilization and transfer of the patient technique (DINO), the physical load caused by transferring patients (PTAI), the care given to residents (Care Thermometer) or the lumbar load supported by caregivers (Dortmund Approach), among other factors. Each of these tools has therefore specific and complementary features that make them valuable to analyze and significant of its inclusion in our study. Below is a brief summary of the characteristics of each method and the way each one values the exposure risk.

2.1. Brief description of the assessment methods

2.1.1. MAPO

The MAPO method (*Movimentazione and Assistenza di Pazienti Ospedalizzati*) assess the risk of transferring patients in different work areas, such as hospitals, nursing homes or hospice services (Battevi et al., 2006). The methodology quantifies the risk level in a unit or service, taking into account organizational aspects that determine the frequency of patient mobilization performed by unit operators. Also, MAPO method assesses the risk of biomechanical overload in the lower back during patient handling.

This method is widely applied from Italy to Spain, where it was recommended by the INSHT (*Instituto Nacional de Seguridad e Higiene en el Trabajo*). The method was validated in hospital and residences for both acute and long-term patients. Nevertheless, the method isn't applicable in accident and emergency, operating theatres and physiotherapy (Battevi et al., 2011).

2.1.1.1. Exposure assessment. With the final MAPO index obtained three possible levels of exposure are defined: negligible (green), medium (yellow) or high (red). From the collected ratings, green corresponds a value between 0 and 1.5, where the risk is negligible, which means that the prevalence of back pain is identical to that of the general population (3.5%). Yellow relates to a range of values between 1.51 and 5, where the back pain can have an incidence 2.5 times higher than green level. Finally, the red level corresponds to a value greater than 5, where the back pain may have an incidence 5.6 times higher (Menoni et al., 1999).

2.1.2. DINO

The DINO method (*Direct Nurse Observation instrument for assessment of work technique during patient transfers*) is a direct observation instrument that assesses whether the work technique of the caregivers performing patients' handling is safe or not (Johnsson et al., 2004). DINO can be used by a person with knowledge in transfer methods and ergonomics, although specific initial training is needed to learn the items, definitions and the scoring system.

The method observes 16 items, divided into three phases of the patient: Preparation phase, Performance phase and Results phase. The method is applicable in wards, in patients' homes, in a classroom setting or in other places where transfers occur. Therefore, it has a wide range of applications, for example to evaluate work technique during patient transfers before and after training, or to register what items nurses do not perform in a safe way in the three phases mentioned.

2.1.2.1. Exposure assessment. For each transfer observed, from the point of view of work safety, the method gives a score. A 1 is granted if the task is safe, and a 0 is given for tasks that are carried out in an unsafe manner and that could derive into a musculoskeletal type risk factor.

2.1.3. PTAI

The PTAI (*Patient Transfer Assessment Instrument*) method is a tool for assessing the load of patient transfers in the unit assessed. Also, the method assesses ergonomic working postures and the workers skills during patient transfer. The method combines the requirements of Finnish occupational safety legislation, ergonomic work postures and patient transfer skills, and has a wide scope of the load caused by patient transfers. The usability and repeatability of the form for evaluating the load of patient transfers has been tested in four surgical wards in the Central Health Finland Care District (Karhula et al., 2009).

The evaluation method has 15 factors observed. The first nine are filled by the assessor observing the work of carers, and the last six are completed based on worker interviews. For its part, the questions of the interview describe the opinion of carers about the overall load of patient transfers. Caregivers answer "Yes" or "No" depending on what situation occurs more often.

2.1.3.1. Exposure assessment. The physical load index is calculated based both on the results of the observations and interview, and expresses the relation between the items that are "In order" and the items that are "Partially in order." The index lower than of 60% stands in the red zone, the index between 60 and 80% corresponds to the yellow zone and the rate over 80% is placed in the green zone.

2.1.4. Care Thermometer

Care Thermometer is an instrument to assess the exposure of physical overload while care is provided to residents (Steer and Knibbe, 2008), and is an evolution of the TilThermometer tool (Knibbe and Friele, 1999). The tool can be used on an international level, as it is shown by a validation study (Knibbe and Knibbe, 2012) that took place in UK, USA, Germany and Netherlands.

Care Thermometer focuses on the evaluation of exposure to physical loads and on the overbearing of suffering musculoskeletal disorders. Such loads may be dynamic, such as lifting or transferring dependent residents, or static, such as adopting an forward-leaning posture over a patient for an extended period of time, or during a resident hygiene. The mobility level of residents is directly correlated to the physical load on caregivers, and therefore with the level of exposure. To monitor the physical load care, Care Thermometer uses the "Mobility Gallery" (Knibbe and Waaijer, 2008), a classification system of five levels of mobility –from A to E– ranging between totally independent and totally dependent residents.

2.1.4.1. Exposure assessment. The three risk levels are correlated by red, yellow and green bar colors, explained as follows:

- red risk level: Transfer or activity is "unacceptable" for the caregiver. In that case, a high risk of physical overload is revealed during transfer activity when comparing equipment provision to resident mobility.
- yellow risk level: Transfer or activity is "unsafe" for the caregiver. The assessment reveals a medium risk of physical overload during the transfer or activity when comparing equipment provision to resident mobility.
- green risk level: Transfer or activity is "safe" for the caregiver. It shows a low risk of physical overload during transfer or activity when comparing equipment provision to resident mobility.

At the end, the method provides a percentage of each risk level, when pointing to the thermometer at the corresponding risk segment, under the heading "Care Temperature" of each unit evaluated. This thermometer reflects the total physical care load, summarizing the risk levels of all activities evaluated.

2.1.5. Dortmund Approach

The Dortmund Approach method is based on several studies framed within the project "Dortmund Lumbar Load Study (DOLLY)" (Jak et al., 2000) about the specific conditions of mobilization of patients performed by a caregiver. The application of the Dortmund Approach to manual patient handling is based on comprehensive laboratory examinations that took place in Germany, in which posture and action forces were measured (Jager et al., 2010). In this context, the lumbar load is quantified, as well as the working conditions that induce a physical overload, in order to implement preventive measures of work design in a biomechanical level. To identify the lumbar overload, that varies due to handling type and transfer mode, as well as due to caregiver's individual performance and patients grade of mobility, the compressive forces of the intervertebral discs were compared with the recommended lumbar load during mobilization, set in the 'Dortmund Recommendations" table, which is divided by age and gender.

2.1.5.1. Exposure assessment.

Dortmund Approach classifies the risk of lumbar overload considering various tasks performed during a patient mobilization. Risk is listed in a three color zones model (green, yellow and red); that is, "Acceptable", "Acceptable under improved circumstances" or "Unacceptable". An unacceptable risk of biomechanical overload is assigned to activities whose compressive forces of the intervertebral discs exceed the recommended limit for gender and age. In contrast, an acceptable risk would be the one whose compressive forces resulting from each task are lower than the lowest recommended limit. Additionally, from each one of these risks stem tips to improve the workplace redesign.

3. Materials and methods

To analyze the functionality of the methods included in this study, a previous fieldwork has been conducted in various hospital wards and operating rooms of a public health service hospital, in order to verify in practice the limitations and particularities of each method comparatively, as well as to define as accurately as possible how the results can be interpreted. This fieldwork was also useful in determining the precise observations that are reflected in the results tables of each method (Tables 2—6). The expert responsible for conducting all the assessments with the different methods was the principal author of this article. After more than ten years of experience working as an ergonomist in a public hospital, the training in the use of the five methods was acquired two years before the fieldwork was made, consulting some of the authors of the different tools the proper use of them, to ensure every aspect of its correct application. With these premises a risk assessment work was performed through the month of October 2012 at the Lucus Augusti Hospital (Lugo, Spain) with MAPO, DINO, PTAI, Care Thermometer and Dortmund Approach methods. In this study six predominantly

medical units of hospitalization were analyzed, within a total of sixteen: Digestive-Infective, Pulmonology, Urology-Ophthalmology, Nephrology-Vascular, Hematology-Oncology and Internal Medicine, which gather a total of 204 beds and 130 workers (66 nurses, 48 nursing assistants and 16 orderlies). Seven types of operating rooms existing in the hospital, namely Gynecology-Urology, General Surgery, Traumatology, Urgencies, Neurology, Vascular and Otolaryngology, were also assessed, which included 74 professionals (40 nurses, 19 nursing assistants and 15 orderlies). In all the units informed consent was demanded before performing the risk assessments, receiving all the nursing supervisor's approval. In sum, there have been evaluated 37.5% of all inpatient units, including 31.8% of the enabled hospital beds and 42.8% of the operating rooms. Regarding the number of professionals, it was considered 32.1% of all inpatient hospital workers, as well as 33.8% of the operating room workers.

In that study, it were observed the main tasks carried out during patient handling (postural changes, transfers, hygiene), the organizational and work environment aspects (rooms condition, mechanical aids), and the ergonomic aspects of those tasks that involve some problems, such as musculoskeletal disorders and occupational accidents resulting from transferring patients.

3.1. Comparison and scoring criteria

Once understood the performance of the assessment tools described after the fieldwork, ten items were selected to facilitate the comparison between methods. The selection of the considered items was based on the similarity of content in specific risk assessment methods of patient handling, and these items were also similar to those that have been selected in related studies (Tamminen-Peter et al., 2009). The items have been obtained from the evaluation criteria contained in each of the methods, allowing a complementary vision that integrates the partial assessments for which each method is characterized. The final adopted scoring criterion was to assign a specific weight to each item according to the frequency that this specific item is considered in all methods (see Table 1). The maximum score of each item is then determined by assigning the same score of the frequency observed for that item.

After establishing the maximum score assigned to each item, which is indicated below after each item, we have developed the criterion by which we have scored each of the sub-items. This criterion was based on the need to divide the maximum points of the item by each of the previously identified sub-item categories. We have also included some main literature references for each item. However, we should highlight that when we cite some of the existing literature references for each item, the idea is to indicate which publication we have relied on for this task. This does not mean that the score of that item is given according on how large is the available literature references for each item. Therefore, the number of mentioned references does not correspond to the score

Table 1
Frequency of repetition of the items analyzed in each method (✓: Yes; ✗: No).

Valued items	MAPO	DINO	PTAI	Care	Dortmund	Frequency
1. Specificity	✓	✓	✓	✓	✓	5
2. Dependency level	✓	✗	✗	✓	✓	3
3. Environmental conditions	✗	✗	✓	✗	✗	1
4. Workspaces	✓	✓	✓	✓	✓	5
5. Mechanical aids	✓	✓	✓	✓	✓	5
6. Postural analysis	✗	✓	✓	✓	✓	4
7. Task outturn	✗	✓	✗	✓	✗	2
8. Work organization	✓	✗	✓	✗	✗	2
9. Training	✓	✗	✓	✗	✗	2
10. Risk perception	✗	✗	✓	✗	✗	1

assigned to each sub-item.

3.1.1. Specificity of the method and data collection (ISO/TR 12296:2012). Maximum 5 points

Four sub-items are scored according to the total adaptation of each aspect, with the following criteria:

- Specificity: 0 or 1.25 if the method is specific for evaluating handling patients or not.
- Data collection: 0 or 1.25 if it's taken into account the objective technical assessment, as well as the workers opinion.
- Assessment time: 0 or 1.25 depending on the complexity and time involved to perform the evaluation.
- Final Score: 0 or 1.25, if a final risk index of the analyzed factors is provided.

3.1.2. Dependency level of the patient (Knibbe and Waaijer, 2008). Maximum 3 points

Score is given depending on the detailed level given about the mobility and collaboration of patients during their transferring, as follows:

- 1.5 points: Indication of the possibility of patient cooperation.
- 3.00 points: Detailed degree of patient dependency, either partially (partially co-operator) or totally (not co-operator).

3.1.3. Environmental conditions (Zimring and Ulrich, 2004). Maximum 1 point

Each sub-item is scored considering if the method contemplates each of the following aspects, according to this criteria:

- "Temperature": 0 or 0.25 if the method takes into account the temperature of the work environment.
- "Lighting": 0 or 0.25 if the method considers the accurate lighting conditions for work.
- "Humidity": 0 or 0.25 if the method takes into account the workstation humidity.
- "Noise": 0 or 0.25 if the method evaluates the acoustic discomfort due to background noise.

3.1.4. Workspaces (Knibbe and Knibbe, 1996; Runy, 2004; Victorian WorkCover Authority, 2004). Maximum 5 points

Each sub-item is scored maximum with one point, depending on whether the method considers each aspect, according to the following criteria:

- "Rooms": 0 or 1.25 if the method takes into account the room space for safe handling.
- "Showers": 0 or 1.25 if showers and its different elements are considered to conveniently make the patient hygiene.
- "Bathrooms": 0 or 1.25 if the method takes into account the space of the bathroom, the opening of the doors or the height of the toilet mug.
- "Height adjustment for beds and stretchers": 0 or 1.25, if it's considered the possibility of regulation of beds or stretchers, to transferring patients onto an appropriate height.

3.1.5. Mechanical aids (Knibbe and Knibbe, 2003). Maximum 5 points

Score is given depending if there are different kinds of major aids (hoists, electric beds, etc..) or minor aids (transfers, rollers, etc.)

used during the patient handling, as follows:

- 1.25: mention of the existence of aids.
- 2.50: aids listing.
- 3.75: aids classification.
- 5: detailed classification of aids.

3.1.6. Task execution and postural analysis (Marras et al., 1999). Maximum 4 points

Each sub-item is scored with one point if the method takes into account each of the following sub-items, according to these criteria:

- "Arms and shoulder girdle": 0 or 1, whether or not the method considers tasks performed by upper limbs.
- "Coordination and balance" 0 or 1, if is taken into account or not the caregiver coordination of movements, whether the task is performed alone or accompanied by another worker, as well as the caregiver correct balance while handling a patient.
- "Lumbar back load": 0 or 1, if the existence of forced postures during transferring of patients involving any type of lumbar back load is assessed or not.
- "Legs and pelvic girdle": 0 or 1, if there are considered or not the tasks performed with lower limbs and waist.

3.1.7. Task outturn (Kjellberg et al., 2004; NHS Estates, 1997). Maximum of 2 points

Score is given, depending if the method takes into account the correct positioning of the patient after a transferring task, with 2 points. Otherwise, 0 points are assigned.

3.1.8. Work organization (Kjellberg et al., 1998). Maximum of 2 points

Each sub-item is scored based on the adequacy or inadequacy of each aspect, according to the following criteria:

- "Working pace and pauses": 0 or 0.50, if the method considers or not the working pace, the frequency of mobilization or the breaks taken by the caregiver.
- "Patient/caregiver ratio": 0 or 0.50, if it is taken into account or not the ratio between the number of patients and the number of their caregivers.
- "Night work": 0 or 0.50, if it is considered the night work of carers.
- "Peer support for mobilization": 0 or 0.50, if it is considered the assistance from colleagues to mobilize a patient.

3.1.9. Training (Martimo et al., 2008; Schibye et al., 2003). Maximum of 2 points

Score is given depending if the method checks or not the specific training of caregivers handling patients, as follows:

- 1 point: reference to training.
- 2 points: specific training of workers and its detailed characteristics considered.

If there is no reference to training, 0 points are assigned.

3.1.10. Risk perception. (Warming et al., 2009). Maximum of 1 point

Score is given depending if the method considers, by questionnaire or interview, that the worker subjectively appreciates that there is either physical load (arduous nature of the task, lack of support from colleagues, continuous dependent patients transfers,

Table 2
MAPO method results.

Ítem	Subitem	Score	Observations
1. Specificity	Specificity	1.25	
	Data collection	1.25	Objective, through technical observation, and Subjective, previous interview with the head nurse of the unit.
	Assessment time	1.25	45 min approximately, considering only the wards assessment time.
	Final score	1.25	Final risk index of three levels.
2. Dependency level	Patient cooperation		
	Degree of patient dependency	3	
3. Environmental conditions	Temperature		The method does not consider any environmental or thermohygrometric
	Lighting		condition.
	Humidity		
	Noise		
4. Workspaces	Rooms	1.25	Space between beds considered.
	Showers	1.25	Doors opening into the showers considered.
	Bathrooms	1.25	Toilet mug height considered.
	Height adjustment	1.25	Regulation of beds, stretchers and assisted bath chairs is taken into account.
5. Mechanical aids	Aids disponibility		It's taken into account major and minor aids, hoists used per patient, its
	Aids listing		ratio and the number of aids available.
	Average rating	3.75	
	Complete classification		
6. Task execution and postural analysis	Arms and shoulder girdle		There are not considered the postures adopted during the mobilization of
	Coordination and balance		patients.
	Lumbar back load		
	Legs and pelvic girdle		
7. Task outturn	Patient positioning		Proper positioning of patients at the end of their mobilization is not considered.
8. Work organization	Working pace and pauses		The night work is considered in the breakdown of workers per shift.
	Patient/caregiver ratio	0.50	
	Night work	0.50	
	Peer support	0.50	
9. Training	Training reference		The method states that training should be 6 h long, with a theoretical and
	Specific training	2	practical content, offered to at least 90% of the caregivers in the last two years.
10. Risk perception	Mental and/or physical load		No questionnaire is designed for this purpose.
Total:		20.25	

Table 3
DINO method results.

Ítem	Subitem	Score	Observations
1. Specificity	Specificity	1.25	Assess the work technique of caregivers during the patient mobilization.
	Data collection	1.25	Workstation is observed. Caregiver's perception about their work is not consulted.
	Assessment time	1.25	20 min approximately, although this may vary according to the dependency level of the patient.
	Final score	1.25	A final risk index value of the assessed unit is not offered. However, it can be obtained an overall score as a summary.
2. Dependency level	Patient cooperation		Patients are classified by their dependency level in the "Background
	Degree of patient dependency	3	description" module (totally dependent, partially dependent and totally independent).
3. Environmental conditions	Temperature		The method does not consider any environmental or
	Lighting		thermohygrometric condition.
	Humidity		
	Noise		
4. Workspaces	Rooms	1.25	It's considered if there is enough space in the room to mobilize a patient.
	Showers		
	Bathrooms		
	Height adjustment	1.25	It's considered whether the bed height is correct or not.
5. Mechanical aids	Aids disponibility	1.25	The method considers if aids for mobilization are used, and if they are
	Aids listing		used correctly. Even so, they are not classified.
	Average rating		
	Complete classification		
6. Task execution and postural analysis	Arms and shoulder girdle	1	The method considers if there is good balance, good coordination,
	Coordination and balance	1	proper economy of motion or how the load on back and shoulders is
	Lumbar back load	1	during patient handling. Also, is seen if there is a proper interaction with
	Legs and pelvic girdle	1	the patient, and if he is allowed to collaborate depending his mobility.
7. Task outturn	Patient positioning	2	It is checked if the technique used for mobilization causes pain to the patients, and if it provokes fear or distrust to them. At the end of mobilization is checked whether the patient is in a correct position or not.
8. Work organization	Working pace and pauses		Although the method makes a prior verification of the working
	Patient/caregiver ratio		conditions, in the check list is only considered if there are "enough
	Night work		nurses."
	Peer support	0.50	
9. Training	Training reference	1	While the work technique is valued, it's only checked if the caregiver
	Specific training		has specific training in the "Background description".
10. Risk perception	Mental and/or Physical load		Perception that caregivers have about their physical or mental workload is not consulted.
Total:		19.25	

etc.) or mental load (time pressure, stress, awareness of the work quality, etc.), as follows: 0.50 points per aspect considered.

4. Results and discussion

In the following tables the results obtained by each of the assessment methods are presented, which are based on the scoring criteria set previously, disaggregating the partial score for each sub-item and stating appropriate observations, if any.

4.1. MAPO

4.2. DINO

4.3. PTAI

4.4. Care Thermometer

4.5. Dortmund Approach

4.6. Summary scores

Table 7 relates all assigned ratings, divided by factors, reflecting also the final score obtained by each method.

Likewise, the methods that best value each of the analyzed factors are presented in Table 8, in order to highlight the strengths of each one. It should be noted that, although the punctuation of items 1, 2, 4, 6 and 7 has been equally scored between some methods, we establish only one method, referenced at the column "High score method", by considering it as the more complete and comprehensive.

In the light of the presented data, we emphasize that, although the five compared methods are similar in nature, as their common starting point is trying to assess the risk that may occur during manual patient handling, the analysis perspective of each of them is different, and therefore the results obtained are also different. All of them have different formats, distinct analyzed factors, and different interpretations and therefore measure with uneven criteria. Thus, although there have been great advances to date, it does not seem to exist a unique method to evaluate fully and comprehensively the risks in the health care sector, at least if we assume that the set of selected factors are those that play the most relevant role in the risk assessment process. In any case, resulting from the comparison made, we observe that MAPO, PTAI and Care Thermometer methods highlights, given the scores obtained, whence we deduce that these tools provide a fairly balanced approach of the diverse variables that in a preventive level are in a hospital environment.

Furthermore, we conclude that DINO and Dortmund Approach methods focus almost exclusively on the technical work of the caregiver and in the detailed postural analysis that ultimately

Table 4
PTAI method results.

Ítem	Subitem	Score	Observations
1. Specificity	Specificity	1.25	
	Data collection	1.25	Data collected through objective observation (nine factors) and subjective (six factors) through the nurses and caregivers interview.
	Assessment time	1.25	45 min approximately.
	Final score	1.25	Final risk index of three levels.
2. Dependency level	Patient cooperation		Patients are not classified by their dependency level.
	Degree of patient dependency		
3. Environmental conditions	Temperature	0.25	The method considers temperature, lighting and draft of the workplace.
	Lighting	0.25	
	Humidity	0.25	
	Noise		
4. Workspaces	Rooms	1.25	Space in rooms, showers and bathrooms is considered, as also the possibility of height adjustment of beds.
	Showers	1.25	
	Bathrooms	1.25	
	Height adjustment	1.25	
5. Mechanical aids	Aids disponibility		The method takes into account the use of major and minor aids, but does not quantify or rate them.
	Aids listing	2.50	
	Average rating		
	Complete classification		
6. Task execution and postural analysis	Arms and shoulder girdle	1	The arms and trunk load is considered, and also the frequency of mobilization and the skill during patient transfer. Load in the lumbar area, legs and foot position is taken into account.
	Coordination and balance	1	
	Lumbar back load	1	
	Legs and pelvic girdle	1	
7. Task outturn	Patient positioning		Proper positioning of patients at the end of their mobilization is not considered.
8. Work organization	Working pace and pauses	0.50	The method considers the working pace and pauses. Although it is consulted if there is more than one caregiver for all lifts, a ratio of patients per caregiver is not set. Workers are also asked in the questionnaire if they receive assistance during mobilization.
	Patient/caregiver ratio		
	Night work		
	Peer Support	0.50	
9. Training	Training reference		Two survey questions focus on training for mobilization and training for the use of aids. It is also stated that should be provided at least one training session in the last two years.
	Specific training	2	
10. Risk perception	Mental and/or Physical load	1	Physical and mental load is considered by interviewing workers.
Total:		21.25	

Table 5
Care Thermometer method results.

Ítem	Subitem	Score	Observations
1. Specificity	Specificity	1.25	Physical care load is assessed during the mobilization of patients, as well as the postural load.
	Data collection	1.25	Objective through a workplace observation, and Subjective with the interview.
	Assessment time	1.25	30 min approximately.
	Final score	1.25	Final risk index of three levels: "safe", "unsafe" and "unacceptable".
2. Dependency level	Patient cooperation		Residents are categorized into five mobility levels from A to E: A
	Degree of patient dependency	3	(ambulatory), B (walk with frame), C (partially dependent), D (dependent in most situations) and E (always dependent on carer).
3. Environmental conditions	Temperature		The method does not consider any environmental or
	Lighting		thermohygrometric condition.
	Humidity		
	Noise		
4. Workspaces	Rooms		Showers are taken into account, the number and manner of use of
	Showers	1.25	shower chairs and trolleys, as well as if showers are adjustable in height.
	Bathrooms	1.25	It is also considered the possibility of regulation of room beds. Regarding
	Height adjustment	1.25	bathrooms, at a postural level are considered during the assessment the tasks of hygiene in baths and the transfers to and from the bathroom.
5. Mechanical aids	Aids disponibility		There are taken into account the hoists used and their quantity (passive
	Aids listing		and active lifts and ceiling hoists) and minor aids (transfers and sliding
	Average rating		material). The method takes into account the correct use of mechanical
	Complete classification	5	aids, based on the dependency of each patient (thirteen different types in the "Equipment availability" module).
6. Task execution and postural analysis	Arms and shoulder girdle		The method takes into account various aspects, such as how are
	Coordination and balance		performed bed transfers, lateral transfers and general transfers. It is also
	Lumbar back load	1	considered the hygienic care in a sitting position and various care
	Legs and pelvic girdle		performed in bed. The cooperation of the patient is measured in the "Resident activity level" module.
7. Task outturn	Patient positioning	2	The method also considers the time required for caring in bed.
8. Work organization	Working pace and pauses		
	Patient/caregiver ratio	0.50	
	Night work		
	Peer support		
9. Training	Training reference		It is not considered the caregiver training.
	Specific training		
10. Risk perception	Mental and/or Physical load		The perception of the caregiver about the mental or physical load is not taken into account.
Total:		20.25	

determines the lumbar load, respectively.

MAPO method considers not only a single risk factor, but an interaction of elements in an integrated manner, and has several virtues, especially its focus on work organization, the average frequency of handling, the conditions of the working environment and the training of workers, but otherwise it does not consider directly the postures taken during the transfer actions. Meanwhile, PTAI method performs a much more complete postural analysis during the execution of the tasks, considering the physical load of the back, arms and legs, as well as the skills during handling patients. However, when consulting employees about their perception of the physical and mental effort, it was possible to see that they are not taking into account the degree of dependency of patients, a key aspect in other tools. Finally, Care Thermometer analyzes the exposure to physical load during patient care and carefully classifies both mechanical aids and the degree of dependency of patients, although it does not value factors such as the environmental conditions or the workers level of training.

5. Conclusions

In conclusion, it should be noted that the health-care sector ergonomists have always tried to find ways to quantify objectively, and as completely as possible, the risks associated with physical stress resulting from manually handling patients, to determine their exposure and thus, therefore, suggest appropriate preventive measures. Although it is undeniable that in recent years several tools to characterize these risks have appeared, assuming a

remarkable evolution in this field, it seems necessary to advance in the improvement of those methods because, even covering a wide range of factors, they exhibit some degree of incompleteness.

As presented in the paper, several methods for evaluating the transferring of patients —included in the ISO/TR 12296:2012— are coincident with each other, while others are complementary because they are not meant to have a global approach of the variables involved in the patient handling risk assessment. After making a comparison taking as reference such criteria, giving to the five methods a score based on their match between them, we see that MAPO, PTAI and Care Thermometer methods provide a more balanced approach of those variables that were taken into account than the methods DINO and Dortmund Approach, tools that rather have specific objectives because they are more focused on the technical performance of patient handling.

Undoubtedly there are some tools that focus on a particular task in an appropriate manner, but if we want to reduce comprehensively the occupational accidents, occupational diseases and other injuries derived from patient handling, it would be positive designing tools to cover as many of the elements that characterize such risks as possible. For this reason, and considering that the least matching criteria could be complementary among each other, we understand that one way to solve this problem would be to develop a new method containing, where appropriate, the best items rated by each method, in which the strengths of each of the five tools analyzed —based on the items that have obtained the highest score— are integrated. With this new method it could be tested the relative contribution of each factor to the different levels of risk and

Table 6
Dortmund Approach method results.

Ítem	Subitem	Score	Observations
1. Specificity	Specificity	1.25	It is assessed the level of biomechanical risk of caregivers, analyzing the postures and movements made.
	Data collection	1.25	Objective, through technical observation.
	Assessment time	1.25	50 min approximately.
	Final score	1.25	A risk level for each task performed is indicated, but a final risk index of the unit is not provided. The compressive load on the lumbosacral area is divided into three levels ("Conventional", "Optimized" and "Optimized with small aids"). The risk of lumbar overload of each task is divided also in three levels.
2. Dependency level	Patient cooperation		Patients are disaggregated into three groups: "fully co-operating patient", "partially co-operating patient" and "without co-operation."
	Degree of patient dependency	3	
3. Environmental conditions	Temperature		The method does not consider any environmental or thermohygrometric condition.
	Lighting		
	Humidity		
	Noise		
4. Workspaces	Rooms		
	Showers		
	Bathrooms		
	Height adjustment	1.25	The method assumes that beds are height-adjustable and adjusted for use.
5. Mechanical aids	Aids disponibility	1.25	It is taken into account how minor aids are placed.
	Aids listing		
	Average rating		
	Complete classification		
6. Task execution and postural analysis	Arms and shoulder girdle	1	Postural analysis is comprehensive, considering different patient-handling activities: raising the patient from lying to sitting, elevating a patient, moving patient towards the bed's head (with caregiver at bed's long side or at bed's head), moving patient side wards, lifting a leg (with caregiver at bed's long side or at bed's head), lifting both legs, inclining the bed's head, shoving a bedpan, placing small aids, transferring a patient from bed to bed, placing a patient sitting in bed to chair and raising a patient sitting in bed or lying on the floor. It is also taken into account the age and sex of the caregiver in the recommended limits for compressive forces on lumbar discs (at "Dortmund Recommendations" table).
	Coordination and balance	1	
	Lumbar back load	1	
	Legs and pelvic girdle	1	
7. Task outturn	Patient positioning		Proper positioning of patients at the end of their mobilization is not considered.
8. Work organization	Working pace and pauses		It is considered that the mobilization is carried out by a single caregiver.
	Patient/caregiver ratio		
	Night work		
	Peer support		
9. Training	Training reference		To grade the risk, it is taken into account if there is an optimized work technique, but it is not considered training or its characteristics.
	Specific training		
10. Risk perception	Mental and/or Physical load		No questionnaire designed for this purpose.
Total:		14.50	

checked, ultimately, its reliability and validity in order to be used as a helpful tool for assessing the existing occupational risks. It should be clarified that, in that sense, the TROPHI method (Fray and Hignett, 2013) already exists, and pursues to measure complex and multi-factorial patient handling interventions, due to the lack of a comprehensive outcome measurement method.

To finish, we should also acknowledge some limitations of this work, such as the fact that this comparison is made only on a qualitative level and not in a quantitative basis, which could serve to endorse the above. Also, it should be pointed out that, although a significant effort to assign objectively scores of the items and sub-items of each method has been made, there is still a certain degree of subjectivity in determining the methods that best value each of the discussed factors. Finally, due to the lack of enough previous research studies on the topic, it was required to elaborate an entirely new criterion to allow the comparison based in scores, which may require further investigation and development.

Table 7
Summary table of the scores (in points) obtained by the assessment methods.

Item	MAPO	DINO	PTAI	Care	Dortmund
1. Specificity	5	5	5	5	5
2. Dependency level	3	3	0	3	3
3. Environmental conditions	0	0	0.75	0	0
4. Workspaces	5	3	5	3.75	1.25
5. Mechanical aids	3.75	1.25	2.50	5	1.25
6. Postural analysis	0	4	4	1	4
7. Task outturn	0	2	0	2	0
8. Work organization	1.50	0.50	1	0.50	0
9. Training	2	1	2	0	0
10. Risk perception	0	0	1	0	0
Total punctuation	20.25	19.25	21.25	20.25	14.50

Table 8
Methods that best value each of the factors discussed.

Item	High score method
1. Specificity	MAPO
2. Dependency level	Care
3. Environmental conditions	PTAI
4. Workspaces	MAPO
5. Mechanical aids	Care
6. Postural analysis	Dortmund
7. Task outturn	DINO
8. Work organization	MAPO
9. Training	MAPO
10. Risk perception	PTAI

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