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ORIGINAL ARTICLE

Quality indicators in interhospital transport: Multicentre project☆

Beatriz Garrido Conde[a,*], Nuria Millán García del Real[b], Teresa Escaplés Giménez[c], Itziar Marsinyach Ros[d], Juan Diego Toledo Parreño[e], María del Mar Nuñez Cárdenas[f], Pedro Domínguez Sampedro[c], Kai Boris Brandstrup Azuero[a], on behalf of the Grupo de Trabajo Transporte Pediátrico y Neonatal de la Sociedad Española de Cuidados Intensivos Pediátricos[1]

[a] *Unidad de Transporte Pediátrico Balear, Hospital Son Espases. Palma, Mallorca, Spain*
[b] *SEMP Hospital Sant Joan de Deu, Barcelona, Spain*
[c] *SEMP Hospital Vall d'Hebron, Barcelona, Spain*
[d] *Unidad Transporte Neonatal de Madrid, Madrid, Spain*
[e] *Unidad Transporte Pediátrico y Neonatal de Castellón, Castellón, Spain*
[f] *UCIP Hospital Virgen del Rocío, Sevilla, Spain*

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Abstract
Introduction: Interhospital transport is carried out by variable teams in different regions of our country, and this makes quality evaluation and benchmarking complicated. Project objective: Select and define a consensual list of quality measurement that may be used by national transport units, whether specialised or not.
Methods: Initial set of quality indicators was proposed by coordinators (members of representative specialised transport units in Spain). Evaluation by selected transport specialists from participating units and SECIP (Society of Paediatric Intensive Care) and SENeo (Spanish Neonatology Society) work teams. Selection of definitive indicators by Delphi method according to relevance and feasibility.

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* Corresponding author.
E-mail address: beatriz.garrido@ssib.es (B. Garrido Conde).

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Results: A total of 35 quality indicators were included in the initial set. Evaluation was carried out by 22 specialists from 7 transport teams. In a first round, 4 indicators were consensually included in the definitive list. Results for the rest of metrics and comments were sent to all participants, and after a second assessment, 11 other indicators reached enough consensus. After list accomplishment, a consensual final definition for every indicator was established.
Conclusions: Using a consensual research method, a list of 15 common indicators was obtained, which may be used by specialised transport teams in our country, and by non-specialised clinics in charge of interhospital paediatric transport. It will allow individual performance to be assessed, as well as benchmarking, in order to find improvement opportunities and ensure the highest quality during interhospital transport.
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PALABRAS CLAVE
Indicadores de calidad;
Mejora de calidad;
Evaluación de calidad;
Transporte interhospitalario;
Benchmarking

Desarrollo de un sistema de indicadores para la evaluación de la calidad en transporte interhospitalario: proyecto multicéntrico

Resumen
Introducción: El traslado interhospitalario se realiza por equipos muy diferentes en las distintas regiones de nuestro país, lo que dificultad la comparación de su calidad asistencial. Objetivo: Seleccionar y definir una lista consensuada de indicadores de calidad aplicable a todas las unidades de transporte, especializadas o no, a nivel nacional.
Material y métodos: Realización de una propuesta inicial de indicadores por el comité coordinador con representantes del transporte especializado de nuestro país. Valoración del listado por especialistas en transporte de las unidades participantes y los grupos de trabajo de SECIP y SENeo. Selección de los indicadores mediante el método Delphi según su relevancia y factibilidad.
Resultados: El listado inicial incluyó 35 posibles indicadores. Fueron valorados por 22 especialistas pertenecientes a 7 unidades de transporte. En una primera fase se eligieron por consenso 4 indicadores, que pasaron directamente al listado definitivo. Se enviaron a los encuestados los resultados del resto de indicadores y las observaciones realizadas por los participantes, y tras ello se realizó una segunda valoración, en la que alcanzaron un consenso aceptable otros 11 indicadores. Tras la elaboración del listado, se estableció de forma consensuada la definición final de cada indicador elegido.
Conclusiones: Utilizando un sistema de búsqueda de consenso, definimos una lista de 15 indicadores comunes, que podría ser utilizada por las unidades especializadas de nuestro país y personal asistencial no especializado que realiza traslados pediátricos. Permitirá evaluar el rendimiento individual y comparar las diferentes unidades para encontrar oportunidades de mejora y asegurar la máxima calidad durante el transporte.
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Introduction

In Spain, there is substantial heterogeneity in paediatric health care transport: the requirement of specialised skills in the stabilization and transport of critically ill infants, children and adolescents is not generalised, and there are differences in the models of delivery of these services between autonomous communities.[1,2]

This variability (which in some instances is even found in neonatal and paediatric transports within an autonomous community) poses a significant barrier to the objective evaluation of care delivery and precludes comparison of transport teams.

The regular assessment of health care quality is essential for the purpose of identifying opportunities for improvement and guaranteeing the best possible quality of care. Indicators are among the most effective tools for this task.

For this approach to be effective, health care teams must use widely accepted and well-defined indicators. This allows comparison of health care outcomes with outcomes reported by other teams or published in the literature, identifying the teams that achieve the best outcomes and adjusting practices to improve patient care (benchmarking).[3]

The establishment of standardised quality indicators with specific reference values, as has been done in other health care fields, would allow assessment of our transport teams through time, comparison with other teams and ongoing improvement of transport services.

The aim of our project was to select and define by consensus a set of quality indicators for neonatal and paediatric

transport services. This set of indicators would be useful to every team that engages in this activity in Spain, specialised or not, and would allow identification of opportunities for improvement in different teams.

Material and methods

Taking as reference similar projects conducted in recent years in other countries or in Spain, but in different health care fields, including those of the Sociedad Española de Urgencias de Pediatría (Spanish Soceity of Paediatric Emergency Medicine, SEUP)[4] and the Sociedad Española de Cuidados Intensivos Pediátricos (Spanish Society of Paediatric Intensive Care, SECIP),[5] we developed a multicentre study with participation of several units throughout Spain. The project was organised in 5 phases.

First phase

The principal investigators contacted the specialised neonatal and paediatric transport units that existed at the time in Spain to set up a coordinating committee in which each of them would be represented, to the end of defining a project that would be relevant to each of the existing care delivery models.

Second phase

After setting up the committee, its members developed an initial list of indicators based on a review of the international literature on the subject and their own personal experience as practicing physicians specialised in neonatal and paediatric transport.

Third phase

The committee developed a list of voluntary collaborators, selected from the pool of clinicians that staffed the participating units, whose task would be to assess the different indicators proposed in the initial list. The committee also asked the collaboration of the working groups on health care transport of the SECIP and the Sociedad Española de Neonatología (Spanish Society of Neonatology, SENeo) to recruit collaborators in transport units other than those represented in the committee.

Fourth phase

Indicators were selected by the Delphi method, starting with collaborators assessing the indicators through an online questionnaire in Microsoft Office Excel® format. Each indicator was rated in terms of its feasibility and relevance on a scale of 1–9 (1 indicating lowest value and 9 the highest value). In addition, participants had to give their opinion on the pertinence of including each indicator in the definitive list. Lastly, participants were directed to provide comments to justify their position, if they deemed it fitting, and were allowed to propose additional indicators for inclusion in the list.

After this initial assessment, the results and comments were submitted to all participants. A second round of assessments was conducted following the same procedure.

In the first round, the indicators selected for inclusion in the list were those with a consensus greater than 95% in support of their inclusion and the highest ratings in relevance as well as feasibility. In the second round, the indicators selected for inclusion were those with a consensus greater than 75% in support of their inclusion and the highest ratings, until the desired number of indicators (12–15) had been selected to adequately address every quality domain defined by the National Academy of Medicine (NAM, previously known as Institute of Medicine) of the United States[6] and the Donabedian model.[7]

Fifth phase

In the last phase of the project, the committee developed the final list of indicators, given the best ratings by participants. The exact definition of each indicator was also established through a consensus process by the members of the coordinating committee, so that any units that wished to use the indicators would have no doubts as to their interpretation.

Results

The coordinating committee was composed of clinicians from 5 specialised transport teams. It generated an initial proposal with 35 possible indicators, shown in Table 1. These indicators were selected based on the literature on similar projects published in other countries, but adapted to the current models of care delivery in Spain and ensuring that all quality domains defined by Donabedian and the NAM were addressed.

We submitted information on the project along with the initial list of indicators to a total of 9 paediatric units throughout Spain (7 specialised paediatric and/or neonatal transport teams, and 2 neonatology units in charge of neonatal transport in their autonomous communities), and distributed it further with the help of the working group on neonatal and paediatric transport of the SECIP and the working group on neonatal transport of the SENeo.

We obtained responses from a total of 22 clinicians in 7 different units, who assessed the proposed indicators.

In the first round, 4 indicators met the criteria for direct inclusion in the final list: accidental extubation, medication errors, correct patient immobilization and use of restraints, and medical equipment failure. After submitting the ratings and comments given in round 1 to participants, the level of consensus was high enough to include another 11 indicators in round 2. Table 2 presents the final list of indicators, each accompanied by the corresponding standard, specific definition and goals, which were also established by consensus by the coordinating committee.

Discussion

Through this project, the researchers achieved the objective of developing a consensus-based list of quality indicators for

Table 1 Initial list of possible indicators proposed by the Coordinating Committee.

	Structure	Process	Outcome
Safety	Medical equipment failure.	Verification of correct ETT placement.	Accidental extubation.
	Unplanned exhaustion of medical gas supply.	Medication errors.	Accidental dislodgment of devices.
		Adequate patient immobilization and restraint.	Transport-related patient injuries.
		Capnography in intubated patients.	Serious adverse events.
		Verification of catheter placement.	ETT displacement.
			ETT obstruction.
			Catheter dislodgement.
			Transport-related crew injuries.
Effectiveness	Use of specialised vehicle.	Successful first-attempt intubation.	Unintentional neonatal hypothermia.
	Transport by specialised physician.	Specific transport report.	Passive hypothermia in HIE.
	Specially trained nursing staff.	Patient triage.	Hypoglycaemia.
	Specially trained medical technicians.	Humidification and heating of inhaled gas.	Hypotension.
			Need of CPR during transport.
Efficiency		Standardised hand-off.	
		Time to stabilization.	
Timeliness			Average mobilization time.
Equitability	Delays due to resource unavailability.		
Patient-centredness		Adequate pain assessment.	Presence of family member during transport.
	Informed consent.		

CPR, cardiopulmonary resuscitation; ETT, endotracheal tube; HIE, hypoxic-ischaemic encephalopathy.

the specific assessment of interhospital transport quality. In the future, this tool will allow objective evaluation of care delivery during transport and comparison of the models of care delivery used by different units.

Paediatric transport is a subspeciality with very specific characteristics that differentiate it from other care fields. On one hand, it involves patients of different ages (from preterm newborns to adolescents) with a broad spectrum of conditions, which requires extensive medical knowledge on the part of providers to ensure accurate identification of the problem and adequate stabilization of the patient.[8] On the other, the intrinsic characteristics of the care environment (limited space and equipment, movement in different vehicles that cause pathophysiological changes, etc.) make transport a process with a very high risk of adverse events.[9] For this reason, professionals involved in paediatric transport must strive to delivery care of the highest possible quality at all times.

Health care quality management systems may use different approaches. In some instances, the methods used to assess transport teams have been too subjective, such as satisfaction surveys of receiving providers,[10] or could not be extrapolated to different teams, such as scores based on the change in condition of patients during transport.[11]

Quality indicators are tangible and quantifiable metrics that can be applied to teams with different organizational models, and therefore are considered among the most effective methods in quality assessment. To be appropriate, they must be relevant, valid, sensitive, specific, useful, reliable, applicable in different settings, easy to measure and therefore, few are actually available, although they are representative of the aspect in need of assessment.[12,13]

Selection of indicators. References in the field of neonatal and paediatric transport

To our knowledge, this is the first time that a list of quality indicators developed by consensus for assessment of neonatal or paediatric transport is published in Spain. The development process started with a search for references in the international literature. The results of the search included a consensus statement published in 2013 by the Ohio Neonatal/Paediatric Transport Quality Collaborative (USA)[14] that proposed and defined 23 indicators at the state level, although the authors did not believe they could be extrapolated to the national level; a Delphi project published in 2015 by the American Academy of Pediatrics (AAP) Section on Transport Medicine[15] that yielded 12 indicators,

Table 2 Consensus-based selection of quality indicators for interhospital transport with their final definitions.

Indicator	Standard	Proposed formula	Target
Medical equipment failure	No instance of medical equipment failing, posing a risk to the patient, during patient stabilization or transport.	[Number of documented medical equipment failures during patient stabilization or transport/number of patient transports during audit period] × 100	0%
Medication errors	No instance of medication errors that pose a risk to the patient during stabilization or transport.	[Number of documented medication administration errors/number of patient transports during audit period] × 100	0%
Accidental extubation	No accidental extubations during stabilization and transport.	[Number of accidental extubations (dislodgment of ETT or tracheostomy tube) during stabilization or transport/number of intubated patient transports during audit period] × 100	0%
Adequate patient immobilization and physical restraints	Every patient correctly immobilized during transport with restrain systems appropriate to the patient's age and medical condition (including adequate immobilization in polytrauma.	[Number of transports in which patient immobilization was appropriate for the patient's medical condition or an age-appropriate restraint system was used/number of patient transports during audit period] × 100	100%
Standardized patient care hand-off	In every transfer, a standardised hand-off protocol is used to ensure correct transmission of information and prevent errors.	[Number of transports with a standardised patient care hand-off performed at receiving hospital/number of patient transports during audit period] × 100	100%
Verification of endotracheal tube placement (ETT)	Correct ETT placement is verified in every intubated patient before departure from originating facility.	[Number of intubated patient transports in which ETT placement (whether or not it was inserted by transport team) was correctly confirmed by at least 2 methods (direct visualization with laryngoscopy, capnography, chest radiograph, lung auscultation, ultrasound)/[number of intubated patient transports in the audit period] × 100	100%
Pain assessment	Adequate assessment of pain in every transported patient with a scale appropriate for age to ensure adequate pain management	[Number of patients that underwent adequate pain assessment with an age-appropriate scale/[number of transports in the audit period] × 100	100%
Accidental dislodgement of devices	No devices are accidentally dislodged or removed posing a risk to the patient during stabilization or transport.	[Number of devices accidentally removed or dislodged (intravenous, intraosseous, umbilical and central catheters, chest drains, other drains, suction catheter) during stabilization or transport/number of patient transports during audit period] × 100	0%
Transport-related patient injuries	The patient is not injured during stabilization or transport.	[Number of injuries in patients related to the stabilization or transport process/number of patient transports during audit period] × 100	0%
Serious adverse events	No serious adverse events that pose a risk to the patient that are not included in other indicators occur during stabilization or transport.	[Number of serious adverse events related to stabilization or transport/number of patient transports during audit period] × 100	0%
Unintended neonatal hypothermia	Adequate control of body temperature during neonatal stabilization and transport with use of the necessary means to prevent hypothermia.	[Number of newborns with a core temperature <36.5 °C on arrival to receiving hospital/total number of neonatal transports during audit period] × 100	0%

Table 2 (*Continued*)

Indicator	Standard	Proposed formula	Target
Average mobilization time of the transport team	In every transport, the mobilization time of the team is within the maximum established for the given team.	[Number of transports in which the number of minutes elapsed from the call to activate the transport team to departure from base less than the maximum established for the team (excluding scheduled transports, return transports or transport of patients from base hospital)/total number of transports audit period (with the above exclusions)] × 100	100%
Passive hypothermia in newborns with HIE	Maintenance during transport of a core temperature between 33.5° and 34.5° (passive hypothermia) in every neonatal patient eligible for therapeutic hypothermia due to HIE.	[Number of newborns eligible for therapeutic hypothermia due to HIE with a core temperature (oesophageal or rectal) between 33.5–34.5 °C during transport / total number of newborns eligible for therapeutic hypothermia due to HIE transported during audit period] × 100	100%
Capnography monitoring of ventilated patients	Continuous monitoring of expired CO_2 in every intubated patient to ensure correct intubation and ventilation of the patient, except for newborns (possible large dead space).	[Number of ventilated patients (excluding newborns) monitored with capnography during transport/total ventilated patients (excluded newborns) transported during audit period] × 100	100%
Medical gas supplies	The supply of medical gases required by the patient does not run out during stabilization and transport.	[Number of instances of unplanned exhaustion of the supply of a medical gas (oxygen, compressed air, nitric oxide) during stabilization or transport/number of transports of patients requiring administration of medical gases during audit period] × 100	0%

ETT, endotracheal tube; HIE, hypoxic-ischaemic encephalopathy.

which have since been used to monitor the activity of transport teams at the national level; and most importantly the Ground & Air Medical Quality in Transport (GAMUT) database of the Air Medical Physician Association (AMPA),[16] created in 2014, which includes 27 indicators that are applicable to both adult and paediatric transport teams.

The initial selection of indicators made by the coordinating committee included the indicators of the cited sources that the committee deemed most relevant for paediatric and neonatal transport in Spain and excluded those that were not considered pertinent, such as indicators that are mostly relevant in the adult care setting.

Later on, the remaining participants included some indicators considered particularly relevant with nearly unanimous consensus, such as the absence of medical equipment failures or accidental extubation, and eliminated other indicators that would be difficult to modify because the team could not address them directly (such as presence of nursing staff or specialised technicians) or that reflected events that were not frequent enough that their monitoring would be relevant (such as the need of resuscitation or transport crew injuries).

Delphi method to establish consensus-based quality indicators

As has been the case in similar projects, the most limiting challenge was the lack of gold standards that would serve as a reference with which to assess potential indicators, which is the reason why we resorted to a method based on expert opinion in lieu of the scientific evidence that is not currently available.

The Delphi methods is a widely used process for the development of quality indicators in the health care field, involving a systematic approach to generating consensus, with development of content through a series of rounds or questionnaires.[17] One of its strengths is its considerable feasibility, allowing participation, possibly on an anonymous basis, of a large number of evaluators who are geographically apart and without need of meeting in person. In our case, since we selected evaluators that were active practitioners, the method offered the added advantage that the indicators were developed by the same professionals meant to use the resulting tool.

We believe that this consensus-based list meets the objective of including indicators addressing the three domains of health care quality included in the model published by Donabedian in 1966: structure (elements required for care delivery, such as infrastructure, equipment, staff, education etc.), process (what is done in care delivery, including processes in diagnosis, treatment, prevention etc.) and outcome (individual health outcomes and public health outcomes)[7].

The selection also covers the six key aims in quality improvement of the NAM model, explained in its publication *Crossing the Quality Chasm: a New Heath System for the 21st Century*[6] (2001): safety, effec-

tiveness, equitability, timeliness, efficiency and patient-centredness.

There are limitations to our study, including the fact that the Delphi method does not have a fully defined design, leaving the conditions required for consensus or the number of rounds to the judgment of the coordinators. In addition, the selection of indicators by consensus does not guarantee their validity or usefulness, as it is not based on an objective approach but depends on the subjective opinion of the panel of experts, as mentioned above.

Conclusions

Using a consensus process, we developed a list of 15 widely used indicators based on the international literature and our professional experience. This list may be used both by specialised units in Spain and by nonspecialised health care staff performing paediatric interhospital transports. The list is meant to facilitate quality assessment in paediatric transport, not only at the level of individual teams, but also for comparison of different units, with the ultimate aim of identifying opportunities for improvement and guaranteeing the highest quality of care.

Conflicts of interest

The authors have no conflicts of interest to declare.

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