SAFETY IN HEALTH

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Evolution of patient safety culture in Belgian acute, psychiatric and long-term care hospitals

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Abstract

Background: In Belgium, the federal government launched a national program to support hospitals for implementing quality and patient safety strategies. One of the main objectives in the federal program is the development of a safety culture. The purpose of this study was to examine to what extent the hospitals' safety culture evolved after participating in the federal program and to explore predictor variables of safety culture.

Methods: In a cross-sectional follow-up design, safety culture was measured in the Belgian acute, psychiatric and long-term care hospitals using validated translations of the Hospital Survey on Patient Safety Culture in Flemish and French. For both nationwide measurements, hospitals were invited to participate in a benchmark research organized by an academic institution (in 2008 and 2012). Generalized Estimating Equations models were fitted to examine the effect of predictor variables on safety culture perceptions.

Results: The Belgian safety culture database contains data from 115 827 respondents from 176 hospitals. For 111 hospitals that participated in both benchmarks it was possible to calculate changes in safety culture. The response rate for the second measurement (52.2%) was comparable to the response rate in the first measurement (51.0%). Improvements were observed for most safety culture dimensions with a major significant improvement for 'Management support for patient safety'. Although 'Handoffs and transitions' and 'Frequency of events reported' were key areas within the federal program, a decline was observed for these dimensions. Work area, staff position, language (regional context of hospital), hospital type and hospital statute were found to have important effects on safety culture perceptions. Hospital size and work experience, showed to have less effect on safety culture scores.

Conclusions: Large comparative safety culture databases allow identifying patterns and trends. Our findings on variations in safety culture perceptions between types of hospitals, hospital units and professional groups implicate the need for a tailor-made approach for safety culture improvement. Future research should focus on enriching the evidence of the effectiveness of safety culture strategies and linking of safety culture and outcomes of care in order to assess the practical validity of safety culture surveys.

Keywords: Organizational culture, Benchmarking, Patient safety, Hospitals, Generalized estimating equations

Background

Since the publication of the report 'To err is human' by the Institute of Medicine (IOM) in 1999, public attention was drawn to the magnitude and severity of the issue of patient harm from medical errors [1]. Since then, patient safety is an important global challenge. Yet, the importance of a safety culture in patient safety improvement is widely accepted within healthcare organizations. The report of the IOM highlighted the importance of a safety culture as 'health care organizations must develop a culture of safety such that an organization's care processes and workforce are focused on improving the reliability and safety of care for patients' [1]. The recognition of the importance of safety culture in preventing medical errors led to numerous studies attempting to define the concept [2-4]. Safety culture can be considered as one aspect of the wider culture of an organization and refers to the product of individual and group values, attitudes,

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competencies and patterns of behavior. It implies a strong organizational and management commitment [5].

Surveys are frequently used to measure safety culture in hospitals in order to improve patient safety. This is reflected in an increasing number of publications in this area. Measuring and improving safety culture is encouraged at organizational levels by national health policy makers and accreditation institutions, with hospitals administering surveys at a regular basis. A number of safety culture questionnaires have been used within hospitals for internal assessment and planning of patient safety improvements and for external benchmarking of scores to measure performance [6-8]. In this example, the Hospital Survey on Patient Safety Culture developed by the Agency for Healthcare Research and Quality has been extensively used across different countries [9-14].

Belgian context

In Belgium, the federal program on quality and safety provides a framework for implementing quality and safety strategies in the acute, psychiatric and long-term care hospitals with attention to three pillars according to Donabedian's trilogy: structure (*how care is organized*), processes (*what is done by healthcare providers*) and outcome measurement (*the healthcare results achieved*). The Belgian hospitals are supported by the government on a yearly basis (annual funding of 7.66 million Euros) for implementing quality and safety improvements [15].

The first pillar of the federal program ('structure') aims at developing a hospital-wide safety management system, including the establishment of a strategic plan and committee for patient safety, the implementation of a reporting system for (near) incidents, a classification system for adverse events (ICPS, International Classification for Patient Safety of the WHO), retrospective analysis, prospective risk assessment (Healthcare Failure Mode and Effects Analysis), a safety culture assessment (Hospital Survey on Patient Safety Culture) and the implementation of targeted safety culture interventions based on the hospitals' results of the baseline safety culture measurement. In the second pillar, the program aims at analyzing and improving multidisciplinary intramural and transmural care processes, for instance by conducting a SWOT - Strengths, Weaknesses, Opportunities and Threats – analysis and by implementing PDCA – Plan, Do, Study, Act - cycles. Finally, the third pillar ('outcomes') aims at developing an indicator set for measuring the quality and safety of care within the hospitals. Hospitals are free to address the content of interventions within the three pillars and instructions are guided by the type of hospital (acute, psychiatric and long-term care hospitals). Throughout the federal program, support is offered to the hospitals by organizing workshops and providing tools and information on relevant topics (e.g. Root Cause Analysis, Healthcare Failure Mode and effects Analysis). The federal website provides all the necessary information for the participating hospitals regarding the quality and patient safety contracts. Yearly, the federal government collects information on the adherence to the contracts and provides feedback by publishing a national report of the results [15].

One of the main objectives in the federal program (pillar 1) is the development of a safety culture as a key condition to implement a hospital-wide safety management system. In order to measure safety culture within the Belgian hospitals, the Hospital Survey on Patient Safety Culture (HSPSC) was selected since it covers a broad range of patient safety aspects and previous research demonstrated good psychometric properties of the instrument [16]. Also, previous research confirmed the robustness of the HSPSC, showing that the survey's constructs are useful for measuring patient safety at different levels [13,17]. In addition, the HSPSC lends itself well for internal and external benchmarking purposes. A collective approach enables hospitals to learn from each other and helps identifying patterns in safety culture scores [13].

Problem statement

Yet, the transferability of safety culture data and safety culture strategies is poorly examined. Only few studies examined the effectiveness of safety culture strategies by use of safety culture surveys. Limited evidence supports the effectiveness of 'generic interventions' such as incident reporting, leadership, human factors, accountability, communication, safety walk rounds, educational programs, simulation training and teamwork on safety culture [18]. Safety culture varies over time, across hospitals and on a sublevel within hospitals [17,19]. This variation in safety culture is associated with organizational characteristics, such as hospital size and statute, and personnel characteristics, such as educational background [19]. Therefore, safety culture strategies should be selective and adapted to the local context of the organization. When assessing the generalizability of evidence of strategies, important elements to consider are the management support, extent of implementation and the hospital and personnel facilitating change [18]. Therefore, to improve safety culture it is important to understand the current relationship and the consistency of these elements [20].

Although there is extensive literature on safety culture measurement, there is no guidance for hospitals on how priorities should be determined for improving safety culture and where a cultural change is needed most. In addition, there is scarce evidence on the effectiveness of safety culture interventions [18]. As found in prior studies, benchmarking safety culture scores is found to be a

useful method for internal learning [6,13,21]. Comparative and time series data on safety culture perceptions could provide more guidance for hospitals on how to determine priorities for safety culture improvement.

Purpose

The aim of this study is to investigate to what extent safety culture evolved within the Belgian hospitals after a period of three years using benchmark data. Although it was not feasible within this study to prospectively measure the effectiveness of improvement strategies, we sought to explain the evolution of safety culture based on additional information obtained from the hospitals. Finally, this study aimed at examining to what extent variations in safety culture could be explained by hospital characteristics, including type of hospital, hospital statute, language (regional context of the hospital) and number of beds, and respondent characteristics, such as work area, staff position, work experience and numbers of hours worked per week, while considering the effect of time. Answers to these research questions could have implications for policies aiming at implementing interventions to improve safety culture.

Methods

Study design and setting

A cross-sectional follow-up study design was used to measure the evolution of safety culture in Belgian acute, psychiatric and long-term care hospitals. Between 2007 and 2009, 88% of all Belgian hospitals (180 out of 205) entered the quality and safety program and conducted a baseline measurement of the safety culture in their organization, using a validated version of the HSPSC in Dutch (Flemish) or French [13]. Within the federal contract of the year 2011, 91% of all hospitals (179 out of 197) committed to conduct a second organization-wide safety culture assessment in order to track changes in safety culture.

Instrument and data collection

The HSPSC includes 42 items that assess safety culture on 12 dimensions. Each item is measured on a 5-point Likert scale ranging from 'strongly disagree' to 'strongly agree' (with a midway point of 'neither') or from 'never' to 'always' (with a midway point of 'sometimes'). To enhance the suitability of the HSPSC for its use within the psychiatric hospitals, the demographic categories of work area and profession were adapted to the context of psychiatric care.

The survey distribution and data collection for the second nationwide safety culture measurement were identical to the methods of the first initiative [13,19] and were based on the original survey of the Agency for Healthcare Research and Quality (AHRQ) [6]. Distribution of the HSPSC and data collection were organized by the hospitals. A measurement toolkit was available for the Belgian hospitals containing the validated version of the HSPSC (in Dutch and French) and a protocol for data collection and internal feedback [16,22]. The protocol imposed hospitals to conduct the survey within a 13 weeks' timetable and encouraged hospitals to use reminders in order to get satisfactory response rates. Hospitals were free to use paper-based or electronic survey forms. Questionnaires were distributed anonymously to all individuals working in direct or indirect interaction with patients. Workshops were organized for the participating hospitals, in which the objectives and tools for conducting the safety culture measurement were explained.

Hospitals participating in the federal program were invited to join in a benchmark initiative on a voluntary, confidential and free of charge basis. The comparative database is managed by Hasselt University, a neutral academic institution, and is not accessible by the governmental authorities. For analysis and benchmarking purposes, an MS Access-based instrument was designed to standardize data entry and automate the application of the exclusion criteria of respondents and analysis of the results. The Access tool automatically filtered out questionnaires with unanswered sections, fewer than half of the items throughout the survey were answered or all items were scored identically. Additionally, the Access tool provided the possibility to instantly create a hospital report with an overview of the respondent characteristics and the hospital scores on the different items and 12 composite dimensions. Technical assistance was available during the period of data collection and after feedback of the results.

An additional questionnaire was sent to the contact persons of the participating hospitals (in most cases the quality or safety coordinator) in order to obtain information on the adequacy of the safety culture measurement and in order to make an inventory of safety culture interventions that were implemented after the first measurement. More specifically, the questionnaire asked information about (1) the adequate application of the measurement protocol (e.g. target group and use of reminders), (2) whether the measurement was conducted organization-wide, (3) the method of survey administration (electronically, paper-based, or both), (4) the number of distributed and retrieved questionnaires from the physicians and other employees, (5) the number of full-time equivalent (FTE) nurses, (6) the number of hospital beds, (7) the statute of the hospital (private or public), (8) which dimensions were addressed as areas to improve after the baseline safety culture measurement and (9) which interventions were implemented to improve these dimensions (qualitative information). The latter included any intervention that could improve safety

culture. The data of the additional questionnaire were linked with the safety culture database (at the hospital level). The safety culture interventions, as defined by the hospitals, were inventoried for each dimension.

Statistical analysis

Based on the responses to the survey, mean dimensional scores (range 1–5) were calculated at the respondent level. These scores where then dichotomized by considering scores higher than three as a positive attitude towards patient safety (binary score = 1 if mean answer >3; binary score = 0 if mean answer ≤3).

Summary dimensional scores were computed at the hospital level corresponding to the proportion of respondents expressing a positive attitude towards patient safety. The baseline and follow-up summary dimensional scores were compared for hospitals that completed both surveys. The relative change in each of the 12 dimensional scores was calculated by deducting the summary dimensional scores of the two measurements. Statistical significance of improvement is greatly influenced by sample size. So as the number of observations gets larger, small differences in scores will be statistically significant. While a 1 percent difference between dimensional scores might be 'statistically' significant (that is, with high probability not due to chance), the difference is not likely to be meaningful or 'practically' significant. Therefore, we followed the recommendation of the AHRQ to use a 5-percentage point as a meaningful difference to consider [23]. Since no normality of the population distribution could be assumed, the Related Samples Wilcoxon Signed Rank test was used to compare the distribution of the two repeated measurements.

A more rigorous multiple regression analysis was performed on the binary safety culture data from both measurement times of all trending hospitals. Because it can be assumed that measurements from respondents within the same hospital are more alike than measurements from different hospitals, the method of Generalized Estimating Equations (GEE) was proposed as an analysis tool. This method allows examining and estimating any possible relationship between safety culture predictor variables and each of the 12 safety culture dimensions, while taking the within-hospital correlation into account. A complete case GEE analysis would only be valid under the assumption of data being Missing Completely At Random (MCAR) [19], but considering only fully observed cases would lead to a substantial loss in estimation efficiency. For this reason, missingness was addressed using the method of multiple imputation, which is also valid under the less strict Missing At Random (MAR) assumption, thus leading to more credible results. This imputation technique replaces each missing value with m acceptable values representing a distribution of 'suggestions'. Given the fact that 3 to 10 imputations are sufficient to obtain stable results, the number of imputations in our study was $m = 5$ [24].

Binary scores of the 12 safety culture dimensions were modeled as the response variables: Supervisor/manager expectations and actions promoting safety (D1), *Organizational learning–continuous improvement* (D2), *Teamwork within units* (D3), *Communication openness* (D4), *Feedback and error communication* (D5), *Non-punitive response to error* (D6), *Staffing* (D7), *Management support for patient safety* (D8), *Teamwork across units* (D9), *Handoffs and transitions* (D10), *Overall perceptions of patient safety* (O1) and *Frequency of events reported* (O2). The predictor variables included measurement occasion (first or second measurement), type of hospital, number of beds, language (regional context of hospital), work area, profession, period working in the current hospital, period working in the current area, period working in the current profession and hours worked per week (Additional file 1).

A step-down hierarchical model building approach was applied to each of the 12 analyses corresponding to the safety culture dimensions. The initial models contained the main effects of all predictor variables – no interaction effects were considered. In a sequential order, the least significant effects were removed from each model until only significant covariates remained. As a result, for each dimension the 'best' end models are presented (Additional file 2).

The odds ratios (ORs) of the response variables were calculated adjusting for all the predictor variables included in the model. For all categorical covariates a reference level was chosen to which ORs compare. For number of beds, which was considered as a continuous variable, the OR indicates the increase or decrease in the odds of being positive towards patient safety per increase of 10 beds.

All data were analyzed using R 2.15.1, SAS 9.2® and IBM SPSS 20®. The level of significance was chosen to be 5% (i.e. $\alpha = 0.05$) throughout the analysis.

Ethical considerations

To ensure the privacy of the respondents, the survey was conducted anonymously. The researchers obtained institutional permits of the hospitals to analyze and report the results of the safety culture measurements. In order to allow for confidentiality of the hospitals, participating hospitals received a unique code to compare their scores to other hospitals. Formal ethical approval was obtained for publication of data.

Results

Hospital and respondent characteristics

In total, the Belgian safety culture benchmark database includes data from 115 827 respondents from 176

hospitals. Of those, 147 hospitals conducted a first measurement and 140 hospitals repeated the measurement after three years. Several hospitals participated once only in the comparative research. In addition, seven hospitals underwent a hospital fusion in the period between the two measurements, which reduced the number of participants in the second measurement.

Trending of data was possible for 111 hospitals, which participated twice in the benchmark initiative, of which 69 acute, 34 psychiatric and 8 long-term care hospitals. The hospitals' characteristics are presented in Table 1. For the second measurement, a higher number of hospitals applied a mixed method using both paper-based and electronic questionnaires for administering the survey in comparison with the first measurement. In most of these cases, the questionnaires were distributed on paper, while reminders were sent electronically. The overall response rate was higher for the second measurement (52.2%) in comparison with the first measurement (51.0%). The trending database consists of 86 262 respondents. Detailed information on respondents' characteristics is presented in Additional file 3, based on the respondents' answers on the demographical items of the survey.

Evolution of safety culture dimensions

The evolution of safety culture on 12 dimensions is presented by type of hospital in figure 1 (acute, psychiatric and long term care hospitals). Summary dimensional scores are displayed using box plots, which provide an

Table 1 Hospital characteristics and response rates for 111 trending hospitals (measurement 1 and 2)

Type of hospital	AH (n = 69)		PH (n = 34)		LTCH (n = 8)	
Language						
Dutch	48 (69.6%)		28 (82.4%)		7 (87.5%)	
French	19 (27.5%)		6 (17.6%)		1 (12.5%)	
Bilingual	2 (2.9%)		0 (0%)		0 (0%)	
Statute						
Public	49 (71%)		29 (85.3%)		1 (12.5%)	
Private	19 (27.5%)		3 (8.8%)		7 (87.5%)	
Missing	*1 (1.4%)*		*2 (5.9%)*		*0 (0%)*	
Number FTE (nurse)						
<100	35 (50.7%)		19 (55.9%)		8 (100%)	
100 - 499	0 (0%)		11 (32.4%)		0 (0%)	
500 - 999	17 (24.6%)		1 (2.9%)		0 (0%)	
1000 - 1499	6 (8.7%)		0 (0%)		0 (0%)	
≥1500	4 (5.8%)		0 (0%)		0 (0%)	
Missing	*7 (10.1%)*		*3 (8.8%)*		*0 (0%)*	
Number of beds						
<250	15 (21.7%)		17 (50%)		6 (75%)	
250 - 499	26 (37.7%)		11 (32.4%)		2 (25%)	
500 - 999	16 (23.2%)		4 (11.8%)		0 (0%)	
≥1000	5 (7.2%)		0 (0%)		0 (0%)	
Missing	*7 (10.1%)*		*2 (5.9%)*		*0 (0%)*	
	Measurement 1	**Measurement 2**	**Measurement 1**	**Measurement 2**	**Measurement 1**	**Measurement 2**
Survey administration						
Paper	52 (75.4%)	41 (59.4%)	30 (88.2%)	25 (73.5%)	8 (100%)	6 (75%)
Electronic	13 (18.8%)	14 (20.3%)	4 (11.8%)	7 (20.6%)	0 (0%)	2 (25%)
Mixed-mode	4 (5.8%)	13 (18.8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Missing	*0 (0%)*	*1 (1.4%)*	*0 (0%)*	*2 (5.9%)*	*0 (0%)*	*0 (0%)*
Total respons rate	**49.0%**	**49.4%**	**68.7%**	**74.4%**	**59.5%**	**65.5%**
Physicians	32.9%	33.5%	61.1%	61.3%	39.1%	61%
Employees	52.1%	52.5%	69.0%	75.0%	60.6%	65.7%

AH = Acute Hospitals, PH = Psychiatric Hospitals, LTCH = Long Term Care Hospitals.

indication of the dispersion between hospitals, possible skewness of data and outliers (hospital level). The left boxes present the summary scores of the first and second measurement per type of hospital. The right boxes display the evolution of safety culture per type of hospital calculated by the differences of the scores.

Regression analysis models

Regression analysis was performed to examine the effect of the predictor variables on the 12 safety culture dimensions. Results from General Estimations Equations are presented by marginal Odds Ratios (OR) for each dimension which has a population averaged interpretation (see Table 2 and Additional file 4). Odds ratios of the categorical variables indicate the increase (if OR > 1) or decrease (if OR < 1) in the odds of positive perceptions towards patient safety in comparison with the reference category. For the continuous variable number of beds, the OR indicates the increase or decrease in odds for each increase of 10 beds. Covariates which had no significant effect on the response variables were removed from the GEE model (Additional file 2).

Overall, ORs were higher for the second measurement, indicating an overall positive evolution of safety culture scores, with exception of *Handoffs and transitions* (D10). The lowest ORs for this dimension were found for the pharmacy and medical-technical services (supporting services in psychiatric hospitals) and also for the professions of pharmacists and technicians. Hospital staff working in many different units, the operating theatre, the emergency department and specialized units in psychiatric hospitals were less likely to have positive perceptions for most dimensions and particularly for *Overall perceptions of patient safety* (O1). ORs were found to be higher for staff working in pediatrics. Perceptions on *Staffing* (D7) were found to be the lowest for geriatrics. However, geriatrics, elderly psychiatric departments and behavioral disorder care showed the highest odds for *Organizational learning–continuous improvement* (D2).

Besides variations in safety culture perceptions between hospital units, a considerable disparity in perceptions was found between professional groups (e.g. nurses vs. physicians), and also within disciplines. For instance, results indicated an important gap of perceptions within disciplines between clinical leaders and their assistants (head nurses vs. nurses and nursing aids; head physicians vs. physician assistants/ in training; head pharmacists vs. assistants pharmacy). Also, lower safety culture perceptions were found for administration and middle management (all hospital staff

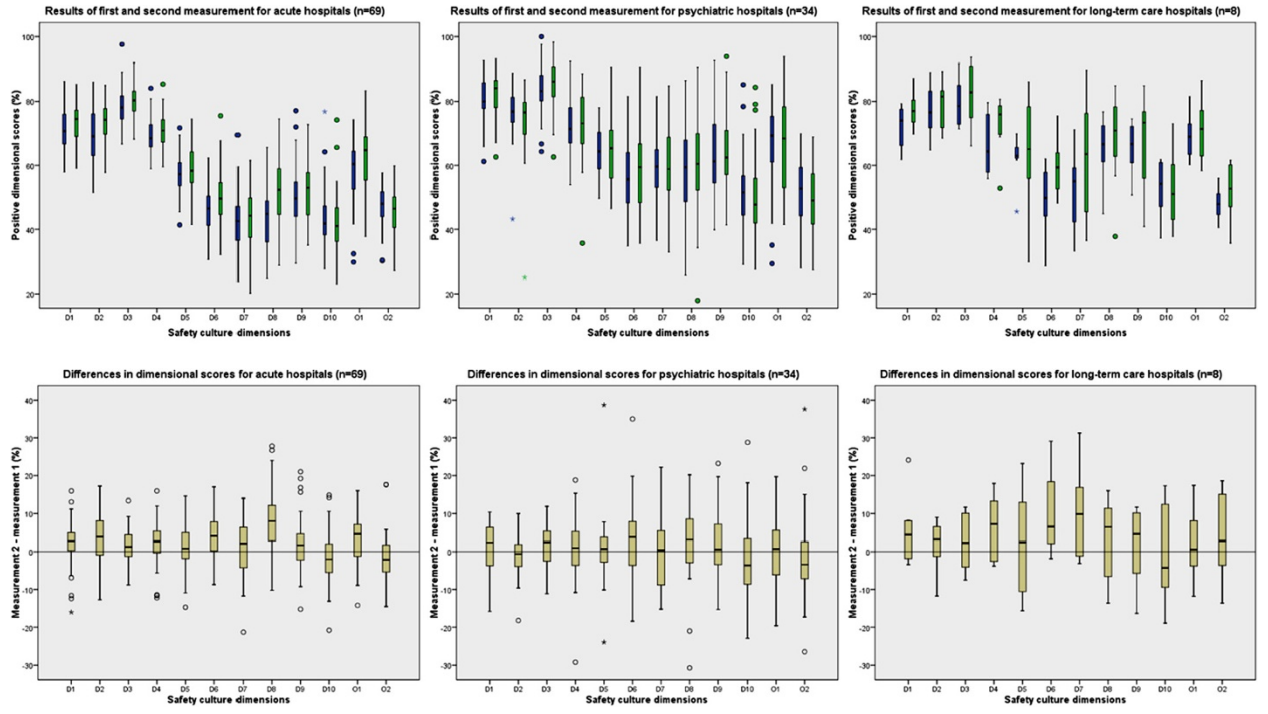

Figure 1 Evolution of safety culture on 12 dimensions (acute, psychiatric and long-term care hospitals). Blue boxplots represent the first measurement; green boxplots represent the second measurement. Dimensions: D1: Supervisor/manager expectations and actions promoting safety. D2: Organizational learning–continuous improvement. D3: Teamwork within units. D4: Communication openness. D5: Feedback and error communication. D6: Non-punitive response to error. D7: Staffing. D8: Management support for patient safety. D9: Teamwork across units. D10: Handoffs and transitions. O1: Overall perceptions of patient safety. O2: Frequency of events reported.

Table 2 Odds Ratios for 12 safety culture dimensions

Variable		Odds Ratio											
		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	O1	O2
Measurement occasion (Reference = First)													
Second measurement		*1.16**	*1.21**	*1.12**	*1.16**	*1.08**	*1.17**	*1.07**	*1.34**	*1.06**	**0.94***	*1.12**	/
	Work area (Reference = Internal Medicine)												
Acute and long-term care hospitals	Surgery	1.02	0.99	**0.89***	0.97	1.04	**0.90***	*1.14**	1	*1.08**	*1.23**	*1.08**	**0.88***
	Operating theatre	**0.75***	**0.82***	**0.44***	**0.77***	**0.72***	**0.81***	*1.08**	**0.83***	1.01	**0.83***	**0.78***	**0.72***
	Gynecology	**0.90***	**0.83***	1.09	**0.90***	0.99	**0.86**	*1.68**	**0.91***	*1.19**	*1.57**	*1.17**	**0.73***
	Pediatrics	*1.34**	*1.26**	*1.48**	*1.45**	*1.23**	*1.28**	*1.76**	*1.12**	1.07	*1.31**	*1.41**	1.08
	Intensive Care Unit	0.96	0.96	*1.14**	1.02	**0.85***	1.03	*1.94**	**0.78***	**0.92***	1.05	*1.18**	**0.77***
	Emergency	**0.77***	**0.62***	**0.80***	**0.80***	**0.73***	**0.64***	*1.09**	**0.70***	**0.61***	**0.86***	**0.58***	**0.60***
	Geriatrics	*1.09**	*1.46**	0.99	1.03	*1.11**	0.98	**0.88***	*1.18**	1	**0.93***	0.95	*1.17**
	Psychiatry	*1.14**	*1.15**	1.07	0.99	1.04	*1.14**	1.82*	0.99	0.99	1	1.07	1.01
	Medical-technical services	0.94	1.04	**0.72***	*1.09**	*1.24**	*1.08**	*2.56**	*1.09**	0.94	**0.67***	*1.61**	*1.08**
	Pharmacy	0.84	0.88	**0.64***	0.97	0.98	1.16	*1.55*	0.95	0.97	**0.46***	1.22	0.93
Psychiatric hospitals All hospitals	Admission/observation/crisis	0.99	0.85	1.06	0.89	1.01	0.94	1.08	**0.76***	0.93	1	**0.83***	0.90
	Specialized unit	**0.76***	**0.82***	**0.70***	**0.81***	0.93	**0.83***	*1.17**	**0.61***	**0.78***	**0.71***	**0.71***	**0.87***
	Day/night hospital	*1.77**	1.08	1.35	*1.50**	1.30	*2.17**	*2.92**	1.21	*1.37**	1.29	*1.64**	0.93
	Psychiatric supporting services	0.93	0.99	0.76	0.88	0.93	0.96	*2.01**	1.08	0.88	**0.62***	1.14	**0.76***
	Addiction therapy	1.35	1.08	1.35	1.31	1.24	1.24	*1.64**	0.92	1.05	1.17	*1.41**	0.83
	Psychosis care	1.37	1.16	1.38	1.36	*1.55**	*1.33**	*1.30**	1.01	*1.61**	1.11	1.23	1.12
	Mood disorder care	1.02	0.90	0.93	0.77	0.91	1.06	*1.57**	0.96	1.33	1.22	1.15	0.88
	Behavioral disorder care	*1.79**	*1.85**	1.45	*1.96**	*2.91**	1.32	1.24	1.10	1.38	1.41	0.80	1.17
	Child psychiatric department	1.10	1.01	1.07	**0.67***	0.82	1.23	0.87	0.94	0.92	*1.38**	0.84	1.13
	Elderly psychiatric department	1.20	*2.26**	0.77	0.97	*1.37**	1.25	1.03	1.24	1.13	0.95	1.07	1.16
	Neurology	0.87	0.64	**0.49***	0.85	1.04	0.83	*1.81**	1.07	1.14	0.63	0.67	0.93
	Many units	**0.78***	**0.83***	**0.82***	**0.80***	**0.75***	**0.79***	*1.15**	1.01	0.99	**0.72***	**0.82***	**0.69***
	Rehabilitation	1.10	*1.20**	1.11	1.07	1.09	*1.23**	*1.90**	*1.19**	1.01	**0.84***	*1.36**	0.96
	Other	1	1.02	0.99	*1.16**	*1.13**	*1.13**	*1.95**	*1.22**	1.06	**0.85***	*1.35**	0.97
	Profession (Reference = Nurse)												
Acute and long-term care hospitals	Head nurse	*1.63**	*1.88**	*2.07**	*2.96**	*1.67**	*2.68**	*1.80**	*1.95**	*1.61**	*1.24**	*1.29**	*1.08**
	Nursing aid	*1.17**	0.98	**0.81***	*1.10**	*1.42**	**0.88***	**0.88***	*1.37**	1.04	1.05	1.06	*1.37**
	Physician	0.96	0.94	*1.51**	*1.53**	**0.96***	*1.69**	*1.99**	*1.35**	*1.47**	**0.89***	*1.71**	0.97
	Physician, Head of department	*1.19**	*1.32**	*1.85**	*2.13**	*1.47**	*2.08**	*2.08**	*1.62**	*1.59**	1.06	*1.99**	1.10

Table 2 Odds Ratios for 12 safety culture dimensions *(Continued)*

Variable		Odds Ratio											
		D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**O1**	**O2**
	Physician assistant/ in training	0.86	**0.65***	0.99	1	**0.76***	1.16	*1.26**	0.94	1.01	**0.74***	1.10	**0.77***
	Pharmacist	*1.64**	*2.13**	*1.80**	*2.20**	*1.43**	*2.11**	*1.40**	*1.77**	1.27	**0.59***	1.29	1.12
	Assistant pharmacy	**0.70***	**0.77***	**0.75***	**0.77***	0.86	0.86	1.13	*1.27**	**0.76***	**0.59***	1.09	1.09
	Administration/ Middle management	**0.90***	**0.79***	**0.89***	**0.84***	**0.87***	1	*1.11**	*1.53**	0.99	**0.72***	1.05	**0.69***
	Technician	**0.74***	**0.75***	1.06	**0.83***	0.98	0.94	*1.31**	*1.12**	**0.91***	**0.73***	*1.27**	1.09
Psychiatric hospitals	Nurse/nursing aid	**0.83***	**0.81***	1.07	1.01	*1.12**	0.96	*1.47**	*1.13**	*1.22**	**0.85***	1.06	1.08
	Physician/Physician head of department/Physician assistant	**0.72***	0.97	*1.77**	*1.72**	1.25	1.72*	*1.50**	*1.62**	*1.56**	0.89	*1.70**	1.22
	Supporting services (pharmacy/assistant pharmacy/technician)	**0.56***	**0.66***	1.02	0.84	1.02	0.90	*1.33**	*1.39**	0.99	**0.60***	1.24	1.10
	Head nurse/Middle management	0.97	1.23	*1.71**	*2.13**	*1.24**	*1.65**	*1.84**	*1.66**	1.43*	1.12	*1.50**	0.89
All hospitals	Therapist	**0.73***	**0.67***	*1.10**	**0.90***	**0.75***	*1.16**	*1.50**	*1.13**	1.05	**0.60***	*1.23**	**0.68***
	Other	**0.78***	**0.74***	**0.85***	0.93	1.06	0.94	*1.11**	*1.29**	0.95	**0.73***	1	**0.91***
Period in current hospital (Reference = 21 years or more)													
Less than 1 year		1.25*	*0.94**	*1.29**	*1.38**	*1.39**	*1.24**	*1.34**	*1.45**	*1.38**	*1.34**	*1.35**	*1.14**
1 to 5 years		0.94	**0.78***	0.99	1	0.95	*1.07**	1.01	1.03	1	1.05	1.05	0.93
6 to 10 years		**0.85***	**0.76***	0.98	**0.89***	**0.85***	**0.934***	0.96	**0.90***	**0.89***	0.974	0.95	**0.88***
11 to 15 years		0.96	**0.91***	0.98	0.96	**0.88***	0.97	1.03	0.94	0.95	1	1.01	**0.92***
16 to 20 years		0.96	0.90	0.97	**0.91***	**0.88***	**0.91***	1.05	**0.92***	0.95	0.964	0.95	0.96
Period worked in unit (Reference = 21 years or more)													
Less than 1 year		*1.16**	*1.15**	*1.29**	/	*1.11**	**0.90***	*1.23**	/	/	/	/	1.07
1 to 5 years		*1.18**	*1.11**	*1.10**	/	*1.07**	0.98	*1.21**	/	/	/	/	*1.09**
6 to 10 years		*1.09**	*1.09**	1.00	/	0.99	1.02	*1.13**	/	/	/	/	*1.10**
11 to 15 years		1.02	1.04	1.04	/	1.02	1.01	*1.13**	/	/	/	/	*1.08**
16 to 20 years		1	1.06	0.99	/	0.99	1.02	1.04	/	/	/	/	1.01
Hours worked per week (Reference =80 hours or more)													
Less than 20 hours		*1.20**	*1.19**	*1.31**	*1.41**	/	*1.24**	*1.74**	*1.48**	*1.31**	*1.36**	*1.31**	/
20 to 39 hours		*1.31**	*122**	*1.31**	*1.43**	/	*1.35**	*1.72**	*1.38**	*1.22**	*1.31**	*1.33**	/
40 to 59 hours		*1.29**	*1.34**	*1.30**	*1.48**	/	*1.36**	*1.37**	*1.34**	*1.19**	*1.20**	*1.23**	/
60 to 79 hours		1.13	*1.37**	1.11	*1.30**	/	*1.19**	*1.23**	*1.27**	1.17	1.05	1.11	/
Contact with patients (Reference = No)													
Yes		/	/	/	**0.92***	*1.27**	/	**0.91***	*1.10**	/	**0.83***	**0.91***	*1.11**

Table 2 Odds Ratios for 12 safety culture dimensions *(Continued)*

Variable	Odds Ratio											
	D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**O1**	**O2**
Period in this profession (Reference = 21 years or more)												
Less than 1 year	*1.18**	*1.14**	*1.40**	*1.26**	/	/	/	0.91	1.04	0.92	*1.31**	0.93
1 to 5 years	1.06	*1.07*	*1.17**	*1.09**	/	/	/	**0.87***	0.97	**0.85***	*0.17**	**0.93***
6 to 10 years	0.96	0.97	1.04	1.04	/	/	/	**0.81***	0.95	**0.85***	*1.08**	**0.90***
11 to 15 years	0.97	0.93	0.97	1	/	/	/	**0.87***	**0.94***	**0.88***	0.98*	**0.89***
16 to 20 years	0.97	0.95	0.94	1.01	/	/	/	**0.91***	0.98	0.95	1.03	0.97
Statute (Reference = Private)												
Public	**0.93***	**0.91***	**0.92***	**0.92***	**0.94***	**0.85***	*1.11*	**0.82***	**0.82***	**0.91***	/	/
Type of Hospital (Reference = Acute hospital)												
Long-term care hospital	1.08	*1.46**	1.12	0.97	1.08	*1.15**	*1.49**	*1.42**	*1.81**	*1.83**	*1.28**	1.06
Psychiatric hospital	*1.82**	*1.53**	*1.22**	*1.22**	*1.20**	*1.41**	*1.52**	*1.32**	*1.37**	*1.41**	*1.32**	*1.19**
Language (Reference = Dutch)												
French	**0.75***	*1.73**	*1.16**	0.91*	0.88*	0.89*	*1.31**	**0.82***	**0.73***	**0.84***	**0.47***	**0.78***
Both (French and Dutch)	**0.73***	*1.59**	*1.18**	1.04	0.92	*0.88**	*1.12**	**0.70***	**0.68***	**0.79***	**0.59***	0.92
Number of Beds [Continuous variable]	*1**	/	*1**	*1**	*1**	*1**	/	**1***	/	**1***	*1**	*1**

P-values ≤ 0.05 indicated by (*); Significant higher odds ratios are displayed in italic, significant lower odds ratios displayed in bold./indicates that the covariate was removed from the GEE model, because of no significant effect on the safety culture dimension under consideration. Dimensions: D1: Supervisor/manager expectations and actions promoting safety. D2: Organizational learning–continuous improvement. D3: Teamwork within units. D4: Communication openness. D5: Feedback and error communication. D6: Non-punitive response to error. D7: Staffing. D8: Management support for patient safety. D9: Teamwork across units. D10: Handoffs and transitions. O1: Overall perceptions of patient safety. O2: Frequency of events reported.

working in administration or holding a managerial function).

Overall, ORs for public hospitals were lower in comparison with private hospitals. Respondents working in psychiatric and long-term care hospitals had higher odds of positive perceptions in comparison with respondents working in acute hospitals. Furthermore, language (regional context) was found to be significantly associated with safety culture perceptions, since ORs of Dutch speaking hospitals were higher in comparison with ORs of French and bilingual hospitals, except for dimensions *Organizational learning–continuous improvement* (D2), *Teamwork within units* (D3) and *Staffing* (D7).

Work experience, such as the period working in the hospital, unit or profession showed to have less effect on safety culture scores. ORs were higher for respondents working less than one year in the hospital in comparison to other hospital staff. Covariates of period working in the unit and profession, hours worked per week and contact with patients did not show significant effects for several dimensions. Finally, hospital size, measured by 'number of beds', was found to have only a small effect on safety culture perceptions.

Strategies for improving safety culture

The evolution of safety culture in the Belgian hospitals measured on 12 dimensions is presented by type of hospital in Table 3. For each dimension it was indicated how many hospitals improved with 5% or more, following the rule of thumb suggested by the AHRQ [23]. Information on improvement strategies was obtained from the hospitals using an additional questionnaire. Hospitals were asked to describe interventions they implemented to improve aspects of safety culture (qualitative information). In Table 3 it was listed for each dimension how many hospitals implemented specific strategies for improving safety culture. Exemplary interventions are provided in the last column.

Discussion

Within a national quality and safety program the Belgian federal government encourages all hospitals to conduct a hospital-wide safety culture measurement at a regular basis using the Hospital Survey on Patient Safety Culture. For research purposes, hospitals are invited to participate on a voluntary basis in a safety culture benchmark database managed by a neutral academic institute. This study presents the largest multicenter safety culture database available within European countries. In our study, a change in safety culture was assessed based on 86 262 respondent records from 111 trending hospitals. Our approach of benchmarking safety culture perceptions is similar to the US comparative database, which includes a total of 359 trending hospitals in 2014 [23]. Response rates were similar to the American survey (54%) and increased from 51.0% for the first to 52.2% for the second measurement. Reminders were an important driver in the survey to get a satisfactory response rate. Similar to other studies, [10,25] lower response rates were observed for physicians (33.5% for acute hospitals) in comparison with other professional groups (52.5% for acute hospitals), which might be an indication for a lower involvement of medical staff in patient safety initiatives. To enhance the usefulness of the HSPSC in psychiatric hospitals, demographic categories of work area and staff position were redefined to the context of psychiatric care. This refinement resulted in lower missing rates for these survey items.

Key areas of attention

Analysis of trending statistics revealed significant areas of improvement and key areas which warrant a higher attention. Improvements were identified for most safety culture dimensions, with a remarkable significant improvement of perceptions for *Management support for patient safety* (D8) within the acute (+8.5%) and psychiatric hospitals (+3.6%). Perceptions of management support for patient safety is derived from survey items such as 'Hospital management provides a work climate that promotes patient safety', 'The actions of hospital management show that patient safety is a top priority' and 'Hospital management seems interested in patient safety only after an adverse event happens' [26]. We found that 66 out of 111 hospitals improved with 5% or more on this dimension. Though, only 15 hospitals indicated that they implemented targeted actions for improving management support for patient safety, such as the establishment of a patient safety committee. Unfortunately, the qualitative nature of information on interventions limits our ability to formulate conclusions on the effectiveness of improvement strategies. However, the general improvement on this dimension might demonstrate the growing involvement in patient safety issues of the hospital management in Belgian hospitals, which is an essential precondition in achieving safe care. Prior studies, as for instance the multicenter study of Huang et al. found that lower perceptions of management were independently associated with increased hospital mortality. Poor perceptions of management may reflect poor hospital management practices that negatively impact patient outcome [26].

Perceptions of *Handoffs and transitions* (D10) and *Frequency of events reported* (O2), which were already found to be low for the baseline measurement, significantly declined. The decline for these dimensions could be explained by the fact that the higher attention paid to these areas within the federal program might have raised the awareness of hospital staff. This could explain the more critical evaluation of these dimensions. However,

Table 3 Strategies for improving safety culture

Dimensions	% of improvement or decline (p-values)			N hospitals with ≥ 5% improvement** (of which N hospitals with targeted strategies)	Examples of interventions targeting safety culture as indicated by participating hospitals
	AH (n = 69)	PH (n = 34)	LTCH (n = 8)		
D1: Supervisor/manager expectations and actions promoting safety	*+2.8* (0.000)*	+2.6 (0.245)	+4.4 (0.093)	32 (2)	Improvement of communication between management and units
D2: Organizational learning–continuous improvement	*+3.9* (0.000)*	−1.0 (0.293)	+3.2 (0.484)	41 (6)	In-hospital patient safety campaign; registration of incidents; raising awareness (posters, dashboard); organizational structural change by implementation of care teams which are accountable for quality and safety; medical record review by quality team; constitution of a patient safety committee; multidisciplinary analysis of events; audits of hospitals units and feedback; encouraging incident reporting
D3: Teamwork within units	*+1.3* (0.002)*	+2.6 (0.084)	+2.3 (0.327)	29 (5)	Designation of unit team leaders; triage on emergency care; optimizing of hospital unit briefings; implementation of safe surgery checklist
D4: Communication openness	*+2.7* (0.000)*	+1.0 (0.281)	+7.2 (0.093)	33 (4)	Communication plan on quality and safety issues; alignment of communication between hospital management and units; presence of hospital management during team meetings
D5: Feedback and error communication	*+0.9* (0.045)*	+0.8 (0.422)	+2.5 (0.674)	28 (9)	Feedback of incident reporting; communication of specific patient safety issues (e.g. hemovigilance); mandatory education of new staff on patient safety; discussion of feedback incident reports with units on regular basis in order to implement improvements; patient safety column in hospital magazine; patient safety dashboard via intranet; designation of incident administrator
D6: Non-punitive response to error	*+4.1* (0.000)*	+4.1 (0.150)	*+6.6* (0.025)*	49 (14)	Involvement of head nurses in feedback and discussion of events; patient safety committee is responsible for communication of patient safety issues to hospital management and hospital staff; education on incident reporting; stimulating a culture of openness and reporting; ending blame and shame culture; drafting a patient safety organogram to enlarge involvement of all hospital committees; sensibilization of head nurses in non-blaming job evaluations; assignment of external company as responsible for incident registration and data processing
D7: Staffing	+2.2 (0.066)	+0.5 (0.966)	+9.9 (0.069)	41 (4)	Support of mobile teams to reduce high workloads; international recruitment of nurses; enhancement of medical staff; clinical receptionists; coaching of new staff; implementation of two night shifts on geriatric, oncology on respiratory units; additional administrative support for nursing care
D8: Management support for patient safety	*+8.5* (0.000)*	*+3.6* (0.041)*	+6.5 (0.401)	66 (15)	Communication of safety culture data; elaboration of a hospital-wide safety plan with SMART objectives for each hospital unit; patient safety on agenda of board meetings; development of patient safety charter; establishment of a patient safety committee; reorganization of quality and safety policy; head physician in lead of root cause analysis of incidents; discussion of patient safety indicators on board meeting; patient safety committee is accountable for incident reporting system; organization of patient safety symposium; organization-wide patient safety campaign
D9: Teamwork across units	*+1.7* (0.039)*	+0.6 (0.231)	+4.6 (0.484)	34 (5)	Mapping and improving transfer processes; examining for all hospital units which information is needed; implementation and evaluation of electronic medical record; exchanging hospital staff across units if necessary

Table 3 Strategies for improving safety culture *(Continued)*

Dimensions	% of improvement or decline (p-values)			N hospitals with ≥ 5% improvement** (of which N hospitals with targeted strategies)	Examples of interventions targeting safety culture as indicated by participating hospitals
	AH (n = 69)	PH (n = 34)	LTCH (n = 8)		
D10: Handoffs and transitions	*−2.0* (0.018)*	−4.5 (0.064)	−4.3 (1.000)	15 (5)	Mapping and improving transfer processes; implementation and evaluation of electronic medical record; implementation and evaluation of protocols for patient identification wrist bands; implementation of nursing transfer checklist
O1: Overall perceptions of patient safety	*+4.6* (0.000)*	+0.5 (0.898)	+0.6 (0.726)	43 (4)	Hospital-wide patient safety campaign; elaboration of hospital-wide procedure book; implementation of targeted actions based on incident reporting; safety walk rounds; elaboration of accreditation processes; patient safety alert weeks; assigning quality labels to hospital units
O2: Frequency of events reported	*−2.0* (0.000)*	−3.7 (0.110)	+2.8 (0.271)	18 (3)	Designation of responsible persons for analyzing incidents; raising awareness on reporting specific types of adverse events; sensibilization campaigns for incident reporting on each unit

AH: acute hospitals; PH: psychiatric hospitals; LTCH: long-term care hospitals.

**Statistical significant* based on Related Samples Wilcoxon Signed Rank test ($p < 0.05$).

**Information on improvement strategies was missing for 8 out of 111 hospitals; The AHRQ's guideline was followed of considering an absolute difference of ≥ 5% in the proportion of positive ratings as potentially indicating a meaningful difference.

these areas warrant a continuous attention. Especially the pharmacists, technicians and therapists had low ratings for *Handoffs and transitions* (D10). These groups of healthcare professionals often provide services to other work units and shift frequently, which could explain the more frequently witnessing of unsafe transmission of patient care information.

Although *Staffing* (D7) has low reliability scores (Chronbach's alpha of 0.57 and 0.52 for respectively the Dutch and French translation [13]) as also reported in American [9,23,27] and other European studies, [10-12,14], this dimension provides important information on the workload for hospital staff. In our study *Staffing* was identified as a major problem within geriatrics, the operation room, internal and surgical units and particularly for the nursing professions. Analysis of demographic items confirmed the problem of staffing and high workloads, since more than a quarter of the Belgian hospital staff indicates to work over 40 hours a week. This area might be less susceptible for progression given the current norms on staffing within the Belgian hospital financing and thus should be a signal for the federal authorities to invest into higher staffing levels, particularly for the nursing profession. The impact of staffing adequacy in hospitals has been the subject of prior patient safety research, demonstrating a clear relationship between nurse staffing levels and the incidence of adverse events [28-30].

Predictor variables of safety culture

In recent literature, there is conflicting evidence to which extent demographic characteristics of healthcare professionals influence safety culture perceptions. Gallego et al. could not explain differences in safety culture scores by demographic characteristics of staff, such as profession or organizational role [31]. In contrary, other studies were able to show differences in attitudes towards patient safety associated with particular groups of healthcare staff [25,32] and across hospital units [17,25,26,32-34]. In our study, profession was identified as an important predictor variable of safety culture. We found an important gap of safety culture perceptions between professional groups and within disciplines. For instance, head nurses showed to have more positive perceptions towards patient safety compared with nurses and nursing aids. Equally, physicians head of department showed to have more favorable safety culture perceptions in comparison with physicians and physicians in training. The gap in safety culture perceptions was most distinct between pharmacists and pharmacy assistants. Possibly, clinical department heads tend to overestimate their units' safety performance and therefore have a more positive perception of safety culture.

Also work area was found to be highly associated with safety culture perceptions. As reported in other studies, respondents working in many hospital units or units delivering more complex and hazardous care, such as the operation theatre and emergency care had less positive safety culture perceptions in comparison with internal medicine units [25]. Pediatrics showed to have a more positive safety culture profile and thus might offer lessons that could be used by other units as recourse to facilitate internal learning.

Besides demographical differences in safety perceptions, also language (regional context), hospital type and statute were observed to account for differences in safety culture profiles. Although small but significant effects were observed for each increase of 10 beds, hospital size could not explain differences in safety culture scores.

Limitations of the study

Our study has some limitations. First, although our study presents a large and representative sample of Belgian hospitals and acceptable response rates, a change of safety culture could only be measured at the hospital level. The anonymous nature of the survey inhibited us to track individual respondents. Perceptions of non-respondents might differ from those of respondents, which could lead to possible bias in our findings [25].

Second, in this study it was not feasible to prospectively measure the effectiveness of single safety culture interventions. In the federal program, hospitals were not instructed or guided to implement targeted actions and were free to address the content of interventions based on their individual safety culture profile of the baseline measurement. We retrospectively collected additional information from the participating hospitals on these safety culture improvement strategies. This information was not verified and thus could have been incomplete or inconsistent. In addition, there is no information on how these interventions were implemented and intervene in practice with other quality improvement strategies, existing policies and procedures within the hospitals. This fact makes it difficult to evaluate whether improved safety culture scores can directly be attributed to specific actions. From an Evidence Based Medicine (EBM) point of view, this study can be categorized as a level 2c study. One of the issues being debated in EBM is 'what does and what does not provide evidence'. A standardized approach of PDCA-cycles should warrant continuous quality improvement, though this seems hard to proof by safety culture measurement. Given the fact that it is difficult to make general recommendations in our study on safety culture strategies, we provided an exemplary inventory of actions from hospitals with improved scores that could have a possible effect on the safety culture dimensions. Nevertheless, our results showed a slight positive evolution of the safety culture in Belgian hospitals after implementation of a national program on quality and safety. From this perspective, both nationwide safety

culture measurements can be seen as interventions as such, which might have raised the awareness toward patient safety within the Belgian hospitals. The wide range of interventions that were implemented in the hospitals within the federal program could have the effect that all dimensions improved a little bit.

Caution must be taken when comparing safety culture scores with other countries, since other data collection methods and analysis techniques could have been applied. For instance, in our study the number of respondents per hospital was taken into account when calculating positive dimensional scores. In the US study, the percent positive scores were calculated by averaging composite-level percent positive scores across all hospitals, leading to an equal weight of hospital scores [23]. In addition, in our study there was a higher participation of staff working in direct interaction with patients (86.8% for acute hospitals) in comparison with the US sample (76%), which hampers a straightforward comparison of scores.

The usefulness of benchmarking safety culture data is heavily discussed in literature. The comparison of quantitative safety culture scores is often limited to mean scores, percent of positive scores, rank-order differences and trending scores of different dimensions of safety culture. As regards content these scores typically indicate areas for improvement. When hierarchically arranged benchmark data also help to identify relative 'underperformers'. Our study adds to this quantitative benchmark approach qualitative information on safety culture strategies. The consideration of these qualitative data was used in our study to support quantitative findings on safety culture improvements. Our study adds to prior research the insight that a variety of safety culture strategies are being implemented in hospitals, probably often without clear knowledge of their effectiveness [18]. Given the limited resources in hospital settings, a continuous and structured evaluation of safety culture using benchmark and time series data is recommended as it will contribute to a better understanding of the impact and sustainability of safety interventions over time [18]. There is a need for further research in this area.

Safety culture research perspectives

Although the psychometric properties and application of the HSPSC have been investigated widely, there is still limited evidence on the relationship between safety culture, individual safety behavior and outcomes of care in order to assess the predictive or practical validity of safety culture survey instruments. In addition, future research should focus on enriching the evidence of the effectiveness of strategies aimed at improving patient safety culture [18]. Also, a better understanding of the role of safety culture as a contextual factor that can moderate the effectiveness of other patient safety practices is required. A rigorous approach for identification and sharing of good practices would enhance insights in the mechanisms underlying safety culture and provide the hospitals with a more practical support for improving safety culture.

Currently, many Flemish hospitals are elaborating a hospital-wide accreditation program and with the aid of hospital associations, a set of quality and safety indicators is being developed. A second federal program for quality and patient safety is elaborated for the next stage of 5 years (2013–2017). This program will focus on specific domains, such as high risk medication, safe surgery, identity-vigilance and transmural care. More generic aspects, such as patient safety management, leadership, communication and patient and family empowerment will also be addressed within the program. A third national safety culture measurement and benchmarking will be organized in 2015 in which federal program needs and hospital accreditation requirements will be aligned. The current developments provide several research opportunities for linking data in order to reveal the importance of safety culture as a breeding ground for quality and safety improvement.

Conclusion

The Belgian safety culture research proves that large comparative patient safety databases allow to identifying patterns and trends and to offer key areas for improvement. Within the Belgian hospitals, a higher attention should be paid to the transmission of patient care information and reporting of (near) incidents. Also, staffing showed to be an area that requires the attention of the federal authorities. The positive evolution on the dimension of Management support for patient safety shows the increasing attention of the hospital management towards patient safety and this is considered as an important precondition for improving safety culture in the Belgian hospitals. Our findings on variations in safety culture perceptions between types of hospitals, hospital units and professional groups implicate the need of a tailor-made approach for improvement strategies within these levels.

Additional files

Additional file 1: Generalized Estimating Equations (GEE) Model.
Additional file 2: Model buiding approach.
Additional file 3: Respondent characteristics for 111 trending hospitals.
Additional file 4: Odds ratios for 12 safety culture dimensions.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions
AV wrote the manuscript. AV and WS collected the data and conceived the statistical methodology. AV, WS and LGB performed statistical analyses. AV and WS had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. WS, JH, MH, HP and NH have been involved in revising the article critically for important intellectual content. All authors have seen and approved the final version.

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