

Where to Focus Efforts to Improve Overall Ratings of Care and Willingness to Return: The Case of Tuscan Emergency Departments

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Abstract

Objectives: Both regression and optimization models were used to identify an efficient combination of aspects of care (e.g., comfort of waiting room) necessary to improve global emergency department (ED) patient satisfaction. The approach, based on patient survey data, tends to favor aspects of care with large regression coefficients and those whose current performance is low, because improvements produce a greater effect on global satisfaction.

Methods: The authors used ED patient satisfaction survey data collected between September and October 2007 from a random sample of 5,277 adult patients who visited 43 EDs in Tuscany, Italy. Ordinal logistic regression models were run to predict overall ratings of care and willingness to return using 20 independent variables (i.e., aspects of care). An optimization model was run to increase these two global items to a maximum of 15%. This model minimizes the total combined percentage increase of the aspects of care. Models using all cases ($n = 5,277$), cases from local hospitals ($n = 4,264$), and cases from teaching hospitals ($n = 1,013$) were run.

Results: Four aspects selected by the optimization algorithm were in all models: "satisfaction with waiting time," "comfort of the waiting room," "professionalism of physicians" (technical skills), and "level of collaboration between physicians and nursing staff." Most aspects needed a 15% increase to comply with the percentage increases set for the global satisfaction items. The model found that to increase overall ratings of care by 1, 2, or 8%, hospitals would need to focus only on one aspect: "level of collaboration between physicians and nursing staff." The total number of variables increased to six when the improvement in overall ratings of care was set at 15%. To increase 3 or 5% willingness to return, the optimization algorithm found that 6 or 14 aspects, respectively, are needed. An increase of 6% or more was unfeasible.

Conclusions: This approach is only somewhat efficient, as a cost structure is absent. The optimization model assumes that the cost to increase each aspect by 1% is equivalent. By applying this modeling technique we have demonstrated that, at least, two elements are important to consider when developing efficient improvement strategies to increase global satisfaction: 1) the current level of satisfaction of the aspects of care and 2) the importance ascribed to the aspects of care. A third element, the cost to increase the aspects of care, might also be important. However, the impact of this element on the optimal solution is currently unknown.

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Patient satisfaction describes the consumer perspective on care services received,^{1,2} and it is considered an important performance measure of the quality of health care.¹⁻⁸ Since the early 1990s, research on patient satisfaction with emergency care has grown steadily, with many studies using multivariate data analytic strategies to identify the factors most predictive of global satisfaction.⁹ A number of studies, including comprehensive literature reviews, have reported patients' interpersonal interactions with physicians and nurses, perceived technical skills, perceived waiting times, and information provided as the strongest predictors of

global emergency department (ED) patient satisfaction.^{9–11} Although focusing on these predictors to improve global ED satisfaction seems to be the correct strategy, it might not necessarily be the most efficient. Two recently published studies proposed a somewhat more efficient approach to help care providers decide where efforts should be directed to increase global satisfaction with services provided.^{12,13} This approach, based on patient survey data, combines the use of both regression and optimization techniques. It identifies aspects of care (e.g., information provided) that need to be modified to produce an improvement in the score of the variable that measures global satisfaction. This approach tends to favor predictors (i.e., aspects of care) with large regression coefficients and those for which their current performance is relatively low, because they produce a greater effect in the score of the global satisfaction variable. As a result, efforts are not always directed toward the strongest predictors identified through regression techniques. This approach has several advantages. First, it not only identifies the predictors to focus on, but it also provides the percentage improvement required by the predictors to gain a desired increase in the score of the global satisfaction variable. Second, by considering the current performance of the predictors, the optimization algorithm tends to avoid those that score relatively high. Third, the predictors from the optimization algorithm are selected with a criterion that minimizes the total combined percentage increase of the predictors. This criterion is important from a management perspective, as it allows managers and clinicians to focus initiatives linked to predictors that strongly influence global satisfaction and that may require less effort or resources to impact global satisfaction.

This approach is relatively new and has only been tested using patient survey data in Ontario, Canada. Therefore, we decided to apply it in a different setting (Tuscany, Italy) to assess its performance, to propose further enhancements to the approach, and to give an efficient solution, in this case, to Tuscan EDs. Our global satisfaction items were 1) “overall, how would you rate the care you received in the emergency department?” and 2) “In case of need, would you come back to the same emergency department?” We aimed to find those aspects of care necessary to increase these two global items by a maximum of 15%.

METHODS

Study Design and Population

The data used in this study were obtained from the Scuola Superiore Sant’Anna Management and Health Laboratory in Pisa, Italy. In 2004, the laboratory was commissioned by the Government of Tuscany (Tuscany Region) to develop and implement a performance evaluation system to comparatively measure and track over time the quality of services provided by health care organizations in Tuscany, which has a population of close to 3.7 million. The Tuscan health care system is universal, publicly funded, and managed through a network of 12 local health authorities (LHAs) and four teaching hospitals (including one children’s hospital), all under the responsibility of the regional administration.

LHAs are responsible for providing care services to the population living in their areas throughout the entire continuum of care, from prevention to long-term care, including acute care. The four teaching hospitals participate in the network by providing high-complexity care. All care services provided in Tuscany, including ED services, are free of charge. In total, Tuscany has 44 EDs; 40 of them are located in local hospitals spread across the region, managed by the 12 LHAs, while the remaining 4 are placed in the teaching hospitals. In 2007, close to 1.3 million visits were recorded in Tuscan EDs.

In this study, we used ED patient satisfaction survey data collected during September and October 2007 from a random sample of patients 18 years of age and older who visited 43 EDs of the 44 EDs in Tuscany. (The one pediatric teaching hospital ED was not included in this analysis.) When the Management and Health Laboratory began its activities, an institutional board (composed of health care managers, physicians, and professors) approved the whole performance evaluation system, including the use of the satisfaction surveys that are part of it. In addition to analyzing patient data according to national regulations on privacy, the laboratory signed a patient confidentiality agreement with the Tuscany Region to assure that patient information would be carefully handled and kept restricted. During the analysis process, patient information was deleted from the database. All patients who visited the EDs during the study period were considered potential subjects and, at triage, they received an invitation letter to participate in a telephone survey to be conducted 1 month after discharge. The letter, which was signed by the chief executive officer of the corresponding health authority or the teaching hospital, contained information about the objectives and content of the survey and how the interview would be conducted. At the end of the letter, patients were asked to sign if they did not want to be interviewed. Exclusion criteria included cases involving psychosis, dementia, and patients who did not explicitly give their consent. In addition, patients who arrived at the ED with an extremely serious condition were also excluded, because it was not possible to give them the invitation letter. Excluding the cases above, during September and October 2007, a total of 72,401 patients were invited to participate, and 47,975 accepted (response rate = 66%). From these 47,975 eligible cases, a sample of 5,277 patients was generated using a stratified random sampling approach, where both the total number of visits at each ED during the study period and the distribution of the level of severity at admission were represented; that is, a quota for each ED/level of severity was generated. Tuscan EDs use a color triage system that reflects the severity of a patient’s condition upon admission, beginning with the color red (very serious) to the color white (not serious).

Survey Content and Administration

A structured questionnaire was used to survey patients with the help of a computer-aided telephone interview (CATI) system. The CATI system selects randomly from each ED and level of severity the number of patients necessary to reach the quota. If a patient cannot be

contacted, then the system selects another patient randomly within the strata until the quota is reached. In total, the CATI system made 24,018 phone calls to reach the required total sample size of 5,277.

The ED questionnaire was designed by considering the current literature and previous surveys undertaken both at national and at international levels. Most questions, however, were taken and adapted from the ED patient satisfaction survey organized by the Picker Institute (Oxford, England) within the British National Health Service (NHS) patient survey program.¹⁴ The resulting patient satisfaction questionnaire had 49 items. Thirty-four items measure different aspects of care (e.g., courtesy of physicians) and two capture global ED satisfaction. The remaining items ask for information regarding arrival at the ED and patient demographics and characteristics. Most items covering aspects of care are assessed using a 5-point scale (e.g., 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = very good) and a 3-point scale (e.g., 1 = no, 2 = yes, sometimes, and 3 = yes, always). Most questions also include a “don’t know” option or a similar response as a possible answer. From the 34 items, those with a high percentage (25% or more) of missing values or with answers of “don’t know” or similar responses were excluded from any further analyses. Examples of these items were those that did not apply to all patients such as items asking about pain while in the ED, anxieties about conditions and treatments, and cleanliness of the bathrooms. Other examples of excluded items were those with a “yes/no” answer such as “were you given enough privacy when being examined or treated?” As a result, 20 items were included in both the regression and the optimization analyses. Confirmatory factor analysis showed that the 20 items loaded on a five-factor model, with Cronbach’s alpha ranging from 0.73 to 0.91. The five factors captured patients’ experiences and satisfaction with physician care, nursing care, involvement in care and information, admission and waiting times, and comfort and cleanliness. To test the predictive validity of the factors, we followed the procedure described by Carey and Seibert.⁶ We first correlated each factor with the global ED satisfaction item; “overall, how would you rate the care you received in the emergency department?” The correlations ranged from 0.37 to 0.75 and were strongly significant ($p < 0.001$), which suggested that all factors were measuring an aspect of patient satisfaction. We then performed multiple regression analysis, which revealed that 82% of the variation of the overall ratings of care was explained by the five factors.

Data Analysis

Following the procedure described by Brown et al.¹² and Sandoval et al.,¹³ we first conducted Pearson correlations to identify which survey questions were significantly associated with both global satisfaction items (i.e., with overall ratings of care and willingness to return). All 20 items from the factor analysis showed significant correlations ($p < 0.01$) with the two global satisfaction items. We then entered all 20 items as predictor variables into two multiple ordinal logistic regression models to determine the probabilities of the

patients’ global evaluations of their ED visit. Finally, we used the optimization model proposed by Brown et al.¹² and Sandoval et al.¹³ to identify the optimal combination of predictors capable of increasing each of the two global satisfaction items by a maximum of 15%. The optimization model works on the regression model and, based on restrictions initially set, the model changes the current score of the independent variables until a desirable increase in the dependent variable is reached. A number of combinations of increases in the independent variables can give the desirable increase in the dependent variable. However, the optimization model selects the one combination where the total combined percentage increase of the predictors is the minimal. The optimization model, fully described elsewhere,¹² incorporates the notion that increasing the score of a variable that is very close to its benchmark value is more difficult than increasing one that is not. Overall, the model tends to favor those aspects that perform poorly but also have a high relative importance measured by the magnitude of the regression coefficients. The factor that results from this combination is the impact in the score of the global satisfaction item. The model selects those factors with the highest impact. For example, consider two aspects of care, both rated using a 5-point scale (1 = very good and 5 = very poor) and both with the same relative importance (i.e., the same regression coefficients), but differing in their current performance. If the score of one aspect is 1.15 (i.e., very close to its benchmark value) and the score of the second aspect is 4.0 (i.e., far from its benchmark value), then the optimization model will select the aspect with a performance of 4.0, because a 10% increase in the score of this aspect will have an impact of 0.4 (10% times 4.0). Instead, the other aspect will have an impact of only 0.12 (1.15 times 10%).

Both the regression and the optimization analyses were performed using all 5,277 cases. Since the optimization model seems to be sensitive to the current performance of the predictors and the magnitude of the regression coefficients, we repeated these analyses separately for teaching and local hospitals. Satisfaction in teaching hospitals might be different than satisfaction in local hospitals (i.e., different predictor scores), and patients in these two settings might have different considerations concerning the same aspect of care (i.e., different regression coefficients). If this is the case, then the optimization results will also be different. A slight difference in the scores of even one independent variable between local and teaching hospitals will give a different optimization solution. Similarly, a slight difference in the regression coefficients between local and teaching hospitals will give a different optimization solution as well. From a management perspective, different optimization solutions mean that strategies to improve global satisfaction in teaching hospitals could be different to those in local hospitals.

Before running all analyses, we performed the following technical changes. First, missing values, answers of “don’t know,” and similar responses were all considered “missing values” and replaced, using the expectation-maximization algorithm. All 20 independent variables had missing values ranging from 1% to

25%. A total of 14 variables had less than 10% missing, and 4 variables had between 20 and 25% missing. Overall ratings of care had 0.35% missing and willingness to return had 0.9% missing. Second, aspects of care assessed on a 3-point scale were transformed to a 5-point scale. This rescaling is necessary to fairly compare the performance level of the different aspects of care, a critical component of the optimization algorithm. A recent study also found no differences in respondent scores when survey data were rescaled to larger numerical scale formats, similar to our case.¹⁵ When necessary, some item scales were inverted to facilitate interpretation and to comply with the model specification where the value of 1 in the 5-point scale must represent the best evaluation possible.¹² The magnitudes of the regression coefficients are presented in this study to assess the relative importance of the predictors. These are the values the optimization model takes to find efficient solutions. Data management and statistical analyses were performed using STATA software (Version 9, StataCorp, College Station, TX), while Microsoft Excel Solver (Microsoft Corp., Redmond, WA) was used for the optimization analysis.

RESULTS

Characteristics of respondents are presented in Table 1. The patients' mean age was 54 years (range, 18 to 100 years), and 47% were male. Most patients (54.4%) were assigned a green color at triage (i.e., moderately serious condition), and close to 60% rated their health at the time of the survey as very good or excellent. About 80% of the patients attended local hospital EDs, whereas the remaining 20% attended teaching hospital EDs.

A total of 80% of patients rated overall care received as very good or good, while 86% said they would definitely come back to the same ED. No statistically significant differences at $p < 0.05$ were observed in these two global satisfaction items between teaching and local hospitals. However, at $p = 0.091$, patients in teaching hospitals were slightly more willing to return than those in local hospitals. Statistically significant differences at $p < 0.01$ were observed for "perceived waiting times," "satisfaction with waiting time," and "cleanliness of the waiting room." For example, 28% of patients in teaching hospitals declared they were seen by a physician in less than 10 minutes, compared to 32% of patients in local hospitals. Other differences between teaching and local hospitals at $p < 0.10$ were observed for "comfort of the waiting room" ($p = 0.065$) and "trust in nursing staff" ($p = 0.07$).

Multivariate Analysis

Table 2 shows the regression results for overall ratings of care and willingness to return when all 5,277 cases were entered in the models. Complete models for teaching ($n = 1,013$) and local ($n = 4,264$) hospitals are available in Data Supplement S1, available as supporting information in the online version of this paper. Before running separate models, we tested the interaction between teaching status (i.e., teaching vs. local) and all aspects of care. In the model predicting willing-

Table 1
Patient Characteristics

Characteristic	Percentage ($n = 5,277$)*
Gender†	
Female	52.6
Male	47.4
Age (years)‡	
18–50	43.2
51–70	30.6
>70	26.2
Color assigned at triage‡	
Light blue/white (not very/not serious)	27.9
Green (moderately serious)	54.4
Yellow/red (very/extremely serious)	17.3
Not given	0.4
Arrival†	
By ambulance	25.3
Other	74.7
Health conditions at arrival†	
Extremely serious	2.4
Very serious	17.0
Moderately serious	46.5
Not very serious	28.0
Not serious	6.1
Health status when surveyed†	
Excellent	11.7
Very good	47.0
Good/fair	31.7
Poor	7.2
Very poor	2.5
Education†	
None	3.5
Primary school	29.8
Secondary school	29.6
High school	29.6
Graduate	7.5
Job status†	
Employed	58.5
Unemployed	2.5
Retired	39.0

*Missing values were replaced using the expectation-maximization algorithm.
†Information obtained from the ED survey.
‡Information obtained from the ED records.

ness to return, the interaction between teaching status and the aspect "level of collaboration between physicians and nursing staff" was statistically significant at $p = 0.030$. This means that patients in teaching hospitals ponder "level of collaboration between physicians and nursing staff" differently than those in local hospitals.

For overall ratings of care, the strongest predictor (i.e., the independent variable with the highest regression coefficient) was "level of collaboration between physicians and nursing staff," meaning the better patients perceive collaboration between physicians and nursing staff, the more likely patients will highly rate overall care received in the ED. Other significant and positive predictors of overall ratings of care, in order of importance, were "clearness of the information provided by nursing staff," "professionalism of physicians" (technical skills), "comfort of the waiting room," "trust in physicians," and "satisfaction with waiting time." Models for teaching and local hospitals revealed similar predictors with "level of collaboration between

Table 2
Ordinal Logistic Regression for Overall Ratings of Care and Willingness to return ($n = 5,277$)

Independent Variable (Aspect of Care)*	Model for overall ratings of care†			Model for willingness to return‡c		
	b§	Standardized b§	p-Value	b§	Standardized b§	p-Value
Courtesy of the registration staff	0.200	0.110	0.002	0.204	0.113	0.007
Ability of the registration staff to understand the severity	0.234	0.129	0.000	0.213	0.117	0.004
Perceived waiting time	0.000	0.000	1.000	-0.069	-0.038	0.211
Satisfaction with waiting time	0.282	0.155	0.000	0.245	0.135	0.000
Comfort of the waiting room	0.305	0.168	0.000	0.230	0.127	0.000
Cleanliness of the waiting room	0.177	0.097	0.002	-0.047	-0.026	0.508
Availability of the staff in case of need	0.102	0.056	0.027	0.196	0.108	0.000
Involvement of the patient in care and decisions	-0.008	-0.004	0.783	0.001	0.001	0.978
Physicians treated the patient like a person	-0.115	-0.064	0.046	0.125	0.069	0.028
Clearness of the information provided by physicians	0.184	0.101	0.014	-0.064	-0.035	0.432
Courtesy of physicians	-0.073	-0.040	0.362	-0.061	-0.033	0.480
Professionalism of physicians (technical skills)	0.523	0.288	0.000	0.304	0.168	0.001
Trust in physicians	0.282	0.155	0.000	0.310	0.171	0.000
Nursing staff treated the patient like a person	-0.081	-0.045	0.199	0.038	0.021	0.550
Clearness of the information provided by nursing staff	0.561	0.309	0.000	-0.088	-0.048	0.481
Courtesy of nursing staff	-0.135	-0.075	0.213	-0.198	-0.109	0.097
Professionalism of nursing staff (technical skills)	-0.086	-0.047	0.485	0.244	0.134	0.069
Trust in nursing staff	-0.219	-0.121	0.000	0.251	0.138	0.000
Patient informed about what to do once at home	0.176	0.097	0.000	0.255	0.141	0.000
Level of collaboration between physicians and nursing staff	2.994	1.651	0.000	0.805	0.444	0.000

*All 20 independent variables were entered simultaneously.
†Likelihood ratio test for model: $\chi^2 = 7321.82$; $df = 20$; $p < 0.0001$; $n = 5277$; $R^2_{Cox \text{ and } Snell} = 0.574$.
‡Likelihood ratio test for model: $\chi^2 = 2189.22$; $df = 20$; $p < 0.0001$; $n = 5277$; $R^2_{Cox \text{ and } Snell} = 0.405$.
§Magnitude of the multiple regression coefficients.

physicians and nursing staff," "clearness of the information provided by nursing staff," and "professionalism of physicians" (technical skills) as the three strongest. However, some differences followed. In teaching hospitals, the aspects "ability of the registration staff to understand the severity" and "clearness of the information provided by physicians" were among the next strongest predictors, whereas in local hospitals the next strongest predictors were "satisfaction with waiting time" and "cleanliness of the waiting room."

For willingness to return, the model in Table 2 showed that the strongest predictor was, again, "level of collaboration between physicians and nursing staff." The next strongest predictors were "trust in physicians," "professionalism of physicians" (technical skills), "patient informed about what to do once at home," "professionalism of nursing staff" (technical skills), and "satisfaction with waiting time." For local and teaching hospitals, some differences were observed. In local hospitals, the strongest predictor was "level of collaboration between physicians and nursing staff," while in teaching hospitals "professionalism of physicians" (technical skills) and "professionalism of nursing staff" (technical skills) were the two strongest predictors, followed by "level of collaboration between physicians and nursing staff." In local hospitals, other strong predictors included "courtesy of the registration staff" and

"comfort of the waiting room," while in teaching hospitals it was the predictors "ability of the registration staff to understand the level of severity" and "availability of the staff in case of need" that were strong.

Optimization Analysis

The optimization algorithm uses the mean value of the global satisfaction item. In a 5-point scale, overall ratings of care averaged 1.89 ($n = 5,277$), and on a 3-point scale willingness to return averaged 1.20 ($n = 5,277$). In both cases, 1 means the best evaluation possible, and the algorithm will search for optimal solutions that comply with a 15% increase, i.e., a value of 1.60 for overall ratings of care (i.e., 1.80 times 0.85) and 1.02 for willingness to return (i.e., 1.20 times 0.85). Table 3 shows the total number of variables (i.e., aspects of care) required to increase the score of the global satisfaction items from 1% to 15%. For example, to increase overall ratings of care by 1, 2, or even 8%, hospitals would need to focus efforts on only one aspect of care: "level of collaboration between physicians and nursing staff." The total number of variables increased to 6 when the improvement in overall ratings of care was set at 15%. For willingness to return, the optimization algorithm found that to increase this global satisfaction item by 3 or 5%, hospitals would need to focus efforts on 6 or 14 aspects of care, respectively. An increase of

Table 3
Total Number of Variables (Aspects of Care) Required to Increase the Score of the Global Satisfaction Items by the Specified Percentage ($n = 5,277$)

Global satisfaction item	Increase in the global satisfaction item, %														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Overall ratings of care	1	1	1	1	1	1	1	1	2	2	3	3	4	5	6
Willingness to return	1	3	6	11	14	Unfeasible									

6% or more was found to be unfeasible. Table 4 shows the aspects of care necessary to increase overall ratings of care by 15% and willingness to return by 3%. Results are presented for all hospitals, as well as for local and teaching hospitals. Four aspects selected by the optimization algorithm were common in all models: “satisfaction with waiting time,” “comfort of the waiting room,” “professionalism of physicians” (technical skills), and “level of collaboration between physicians and nursing staff.” Most aspects in Table 4 need an increase of 15% to comply with the percentage increases set for the global satisfaction items. In addition, some differences were observed. The aspect “clearness of the information provided by the nursing staff” was selected for overall ratings of care but not for willingness to return, while the aspects “trust in physicians” and “professionalism of nursing staff” (technical skills) were selected for willingness to return but not for overall ratings of care. Other unique predictors were also selected. For willingness to return, the aspect “courtesy of the registration staff” was selected only for local hospitals, and “availability of the staff in case of need” was selected only for teaching hospitals.

To further demonstrate how the optimization model selects the final combination of variables, we present in Table 5 the optimal solutions for improvements in overall ratings of care ranging from 1% to 15% (all cases, $n = 5,277$). The model started with the aspect “level of

collaboration between physicians and nursing staff,” the first strongest predictor of overall ratings of care. When the improvement in this aspect reached the 15% restriction, the model added “clearness of the information provided by nursing staff,” the second strongest predictor of overall ratings of care. The process continued until the 15% increase in overall ratings of care was reached. At that point, the models found six predictors as part of the optimal solution. Most of them need an improvement of 15%, with the exception of “ability of the registration staff to understand the severity,” which required an improvement of 4%. This final optimal solution does not include the fifth strongest predictor from Table 2 “trust in physicians.” Instead, the sixth (“satisfaction with waiting time”) and the seventh (“ability of the registration staff to understand the severity”) strongest predictors were selected as part of the optimal solution.

DISCUSSION

This study tested, in a different setting, a recently proposed technique to select aspects of care where efforts should be directed to yield a desired level of improvement in the score of the variable that captures global ED satisfaction. Our global ED satisfaction items were “overall, how would you rate the care you received in the emergency department?” (overall ratings of care

Table 4
Improvements Required to Increase the Score of the Global Satisfaction Items

Peer Group	Aspects of care (optimization variables), %*															
	X ₁	X ₂	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₇	X ₁₈	X ₁₉	X ₂₀
Results for overall ratings of care (by 15%)																
All hospitals ($n = 5,277$)		4	15	15					15			15				15
Community ($n = 4,264$)			15	15	6				15			15				15
Teaching ($n = 1,013$)		14		15					15			15				15
Results for willingness to return (by 3%)																
All hospitals ($n = 5,277$)			15	15					15	7			15			15
Community ($n = 4,264$)	15		15	15					12							15
Teaching ($n = 1,013$)		15	15		6	15			15	15			15			15

*X₁ = courtesy of the registration staff; X₂ = ability of the registration staff to understand the severity; X₃ = perceived waiting time; X₄ = satisfaction with waiting time; X₅ = comfort of the waiting room; X₆ = cleanliness of the waiting room; X₇ = availability of the staff in case of need; X₈ = involvement of the patient in care and decisions; X₉ = physicians treated the patient like a person; X₁₀ = clearness of the information provided by the physicians; X₁₁ = courtesy of the physicians; X₁₂ = professionalism of physicians (technical skills); X₁₃ = trust in physicians; X₁₄ = nursing staff treated the patient like a person; X₁₅ = clearness of the information provided by nursing staff; X₁₆ = courtesy of nursing staff; X₁₇ = professionalism of nursing staff (technical skills); X₁₈ = trust in nursing staff; X₁₉ = patient informed about what to do once at home; X₂₀ = level of collaboration between physicians and nursing staff.

Table 5
Improvements Required to Increase Overall Ratings of Care from 1% to 15% ($n = 5,277$)

Increase in Overall Ratings of Care, %	Aspects of Care (Optimization Variables), %*															
	X ₁	X ₂	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₇	X ₁₈	X ₁₉	X ₂₀
1																2
2																4
3																6
4																8
5																9
6																11
7																13
8																14
9												4				15
10												12				15
11									6			15				15
12									15			15				15
13				10					15			15				15
14			6	15					15			15				15
15		4	15	15					15			15				15

*X₁ = courtesy of the registration staff; X₂ = ability of the registration staff to understand the severity; X₃ = perceived waiting time; X₄ = satisfaction with waiting time; X₅ = comfort of the waiting room; X₆ = cleanliness of the waiting room; X₇ = availability of the staff in case of need; X₈ = involvement of the patient in care and decisions; X₉ = physicians treated the patient like a person; X₁₀ = clearness of the information provided by the physicians; X₁₁ = courtesy of the physicians; X₁₂ = professionalism of physicians (technical skills); X₁₃ = trust in physicians; X₁₄ = nursing staff treated the patient like a person; X₁₅ = clearness of the information provided by nursing staff; X₁₆ = courtesy of nursing staff; X₁₇ = professionalism of nursing staff (technical skills); X₁₈ = trust in nursing staff; X₁₉ = patient informed about what to do once at home; X₂₀ = level of collaboration between physicians and nursing staff.

received) and “in case of need, would you come back to the same emergency department?” (willingness to return). Table 4 shows the predictors selected by this approach to increase overall ratings of care by 15% and willingness to return by 3%. Although there are some differences across hospital peer groups, four aspects were common in all models: “satisfaction with waiting time,” “comfort of the waiting room,” “professionalism of physicians” (technical skills), and “level of collaboration between physicians and nursing staff.” Most aspects need an increase of 15% to comply with the percentage increases set for the global satisfaction items.

Similar to the findings of Brown et al.¹² and Sandoval et al.,¹³ willingness to return was very close to its benchmark value; thus, an increase of 15% was not feasible. The maximum increase possible was 5%, which requires focusing on 14 predictors (Table 3). The model by Brown et al.¹² also found that to increase willingness to return by 5%, 13 predictors are required, and to increase willingness to return by 6%, their study found that 24 predictors would be needed. Similar to our ratings, they also reported that 87% of their patients are willing to return. These higher scores, along with our optimization results, might have important management implications. Improving patients’ willingness to return might require a significant amount of effort as shown by the number of predictors selected by our model. Table 3 shows that an increase of 5% requires 14 predictors. Each predictor might require a different strategy. For example, the strategy needed to improve patients’ perceptions of and satisfaction with waiting times could vary from investing in more capacity, including more staff per patient and more space (or

beds), to new and advanced information technology and medical equipment, all with the goal of decreasing patients’ turnaround. Improving courtesy of physicians and nursing staff might require a strategy that addresses communication and customer service skills. Thus, if 14 aspects of care are needed to increase willingness to return, the number of different strategies might be as high as 14, as well. On the other hand, increasing overall ratings of care might require less effort. Our model shows that even an increase of 8% in overall ratings of care still requires one predictor: “level of collaboration between physicians and nursing staff.” Which global satisfaction item to improve is certainly each hospital’s decision. However, our optimization approach has the potential to indicate to hospital managers and clinicians the amount of effort required to support each option, and some might require resources not simple to quantify.

The approach used in this study, and fully described elsewhere,^{12,13} appears to be generalizable and applicable to any setting where patient satisfaction data are collected; however, the model solution seems to be setting-sensitive. That is, the optimal solution depends on two major components that vary from one setting to another: 1) the current performance level of the predictors (i.e., the level of satisfaction of the aspects of care) and 2) the relative importance of the predictors (i.e., the magnitude of the regression coefficients). By considering these two components simultaneously, the model does not always select the strongest aspects identified through regression techniques. For example, to increase the score of willingness to return by 3%, the model involving local hospital EDs selected the first-, fifth-, sixth-, seventh-, and eighth-strongest predictors

as part of the optimal solution (Table 4). The second-, third-, and fourth-strongest predictors were not selected because their current performance was very close to the benchmark value of 1. This feature is what makes our approach somewhat efficient. One could focus efforts on the second-, third-, and fourth-strongest predictors; however, the percentage increases needed to comply with the 3% improvement on willingness to return would be higher than the optimal solution, which minimizes the combined percentage increase of the predictors.

The findings from both the regression and the optimization analysis imply that the interaction between physicians and nurses is a critical aspect of care. In various patient focus groups conducted in Tuscany, interaction between physicians and nurses was defined by patients as interprofessional collaboration or the ability of nurses and doctors to work as a multidisciplinary team able to share information and update each other about any development regarding patients' condition and care. Patients also underlined the importance of trust and respect in the relationship between doctors and nurses as a condition to foster coordination in decision-making processes. Patients frequently reported that in their ED experiences, there was a lack of continuity of information between professionals. In five of the six models, the aspect "level of collaboration between physicians and nursing staff" was the strongest predictor, and in the model to predict willingness to return involving teaching hospital EDs, this aspect was the third strongest. These findings are not surprising in light of other studies that have demonstrated that a good nurse-physician relationship affects positively the organization in terms of decreased costs, better patient care, economy of decision-making,^{16,17} and decreased patient morbidity and mortality.¹⁸ Similarly, Shortell et al.,¹⁹ who studied the relationship between caregiver interaction and a number of intensive care unit performance indicators, found a positive association between caregiver interactions and four of five unit performance measures, including risk-adjusted length of stay, evaluated technical quality of care, evaluated ability to meet family member needs, and nurse turnover. They captured caregiver interaction through a composite index that included the subdimensions culture, leadership, communication, coordination, and problem-solving/conflict management. In a recent focus group of ED patients conducted in our management and health laboratory, we found two qualitative measures that further support the findings from this study. We first found that patients are aware of the level of collaboration existing between health care staff, and second, we found that a positive interaction between physicians and nurses helps patients to feel comfortable and to contain anxiety during their ED experience.

Some differences found between teaching and local hospital EDs regarding the variables that most influence global satisfaction after the "level of collaboration between physicians and nursing staff" are interesting. Patients' overall ratings of care and willingness to return to teaching hospital EDs seem to be most influenced by aspects related to the skills of the staff, such

as professionalism (technical skills), trust, ability to understand, and information provided. In local hospital EDs, however, aspects like "comfort of the waiting room" and "satisfaction with waiting time" seem to be more important. These differences might be due to the different roles the two health organizations play in Tuscany. Teaching hospitals are, in fact, mostly responsible for dealing with complex cases. Consequently, patients might give greater importance to the skill of the staff there than in local hospitals. In the models predicting willingness to return, "comfort of the waiting room" was the 15th strongest predictor in teaching hospital EDs, while in local hospital EDs it was the 6th strongest. "Comfort of the waiting room" was among the first aspects selected by the optimization algorithm in local hospital EDs, while in teaching hospital EDs it was one of the last.

LIMITATIONS

One of the limitations of our approach relates to the absence of a cost structure in the formulation of the optimization model. This means the model assumes that the cost to increase each aspect by 1% is equivalent. Future research should either explore the use of an appropriate cost structure or simulate differing cost structures to understand what the impact in the selection of aspects of care may be.

Another limitation that deserves some attention relates to the way the Likert scales were used in the optimization model. Instead of using distributions, we used averages. This was done from a practical perspective. Because Likert scales are ordinal, it can be argued that only interval levels exist (e.g., 4 = fair, 3 = good). Forcing the optimization model to move the score of the predictors one point (e.g., from fair to good), which is technically possible, might be inefficient. In the math, moving from 4 (e.g., fair) to 3 (e.g., good) means an increase of 25%. This is rather large, and our model has shown that in many circumstances, the percentage increase needed is less than 25%. For example, Table 5 shows that to increase overall ratings of care by 1, 2, or even 8%, the improvement required for the "level of collaboration between physicians and nursing staff" in all cases is less than 15%. Thus, it would be inefficient to spend time and resources to increase this aspect by more than 15%. Similarly, the model was formulated to be used with continuous variables. For example, the aspect "comfort of the waiting room" has an average of 2.45 ($n = 5,277$). If we were going to force this value into a Likert scale, then what would be the appropriate level (2 = good vs. 3 = fair)? Whatever the choice taken, it would most likely distort the real performance of the aspect and the results from the optimization model. One potential solution to overcome the use of averages is simply to use distributions. That is, if 60% of patients rate "comfort of the waiting room" as very good or good, then the optimization model could evaluate the impact on global satisfaction by moving the score above from 60% to 65%. This will, however, change the formulation of the optimization model and should be considered as an alternative in future investigations.

CONCLUSIONS

We worked with a recently proposed technique that can help health care providers focus efforts on aspects of care that can produce the greatest impact on global satisfaction. Because an optimization model was used, the aspects selected are those whose combined percentage increase is minimal. However, the approach is only somewhat efficient, as a cost structure has not yet been included. If an appropriate cost structure were to be incorporated into this approach, it might prove to be efficient in developing ED patient satisfaction improvement strategies. Altogether, this modeling technique demonstrates that, at least, two elements are important to consider when developing efficient improvement strategies to increase global satisfaction: 1) the current level of satisfaction, and 2) the importance ascribed to the aspects of care. A third element, the cost to increase the aspects of care, might also be important. However, the impact of this element on the optimal solution is currently unknown.

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Supporting Information

The following supporting information is available in the online version of this paper:

Data Supplement S1. Ordinal logistic regression for overall ratings of care and willingness to return (teaching hospitals, $n = 1,013$).

The document is in PDF format.

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