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# Effect of intensive care environment on family and patient satisfaction: a before–after study

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**Abstract** *Purpose:* To determine to what extent intensive care unit environment affects family and patient satisfaction. *Methods:* A before–after study was performed in one university hospital in The Netherlands, 2 months before and 2 months after the migration of an intensive care unit (ICU) with multiple beds on a ward to a newly built ICU with all single rooms. Family and patient satisfaction were determined by two surveys: family satisfaction with care in the ICU and patient satisfaction with care in the ICU, respectively. *Results:* From 387 of 617 (63 %) discharged patients at least one survey (patient and/or family) was returned. Both family and patients were more satisfied with their overall ICU experience in the new ICU as compared with the old ICU. Mean scores for family satisfaction increased from 69.5 [standard deviation (SD) 16.6] to 74.1 (SD 15.2) for old and new ICU, respectively ($p = 0.02$). For patients, satisfaction rates increased from 63.6 (SD 18.9) to 69.6 (SD 18.3) for old and new ICU, respectively ($p = 0.02$). The largest differences on single items of the surveys were noted on environmental aspects. *Conclusions:* This is the first study to quantify the effect of ICU environment on family and patient satisfaction. Family and patient satisfaction with ICU experience increased by 6 % in the new ICU environment with noise-reduced, single rooms with daylight, adapted colouring and improved family facilities.

**Keywords** Intensive care units · Patient satisfaction · Family satisfaction · Health facility environment · Questionnaires

## Introduction

Intensive care units (ICUs) provide a high-tech environment with life-saving treatment. The design of the built ICU environment has evolved over the years, from units with multiple beds in an open area divided by curtains, to units with single, private rooms [1]. It has been suggested that environmental improvements in ICU may affect family satisfaction [2, 3].

Satisfaction is an important outcome when assessing quality of care [4]. While patients are often unable to communicate or participate in decisions, family is considered a substitute decision-maker and important in evaluating satisfaction [5, 6]. Therefore, satisfaction with

care in ICU is often focussed on family [7], usually involving evaluation of care, involvement in decision-making and communication [8–11]. Surveys evaluating patient satisfaction with ICU care are less common, and more directed towards measuring perception and experience of ICU patients [12], often by using general surveys of hospital care [13, 14].

Studies reveal that nursing competence, concern and caring for patients, completeness of information and environmental factors are associated with better overall family satisfaction in ICU [15]. However, the association between ICU environment and satisfaction was based on the comparison of different ICUs, with probable differences in staffing and work processes. It remained unclear whether efforts to renovate or rebuild the ICU environment might improve satisfaction ratings [16]. Furthermore, mainly family satisfaction has been studied. The impact of ICU environment on patient satisfaction has been suggested, based on studies in general wards [17, 18], but has not been studied thoroughly so far.

Recently, a new ICU with single, private rooms was opened at the University Medical Center in Utrecht, The Netherlands, which replaced an ICU with multiple beds on a ward. The new ICU incorporated the concept of healing environment, and all patient rooms have natural daylight, privacy, a view and reduced noise levels [19–21]. The migration of the old, ward-like ICU to the new ICU with only single rooms provided a unique opportunity to quantify the effect of ICU environment on both family and patient satisfaction. We hypothesized that a new patient-centred ICU environment with more privacy would decrease stress [18] and subsequently improve satisfaction. The aim of this study is to determine to what extent ICU environment affects both family and patient satisfaction.

## Methods

### Study design

We used a prospective before–after design. The study periods were January and February 2010 (before migration) and April and May 2010 (after migration). According to the Institutional Review Board the study was not subject to the Medical Research Involving Human Subjects Act, and therefore the necessity of informed consent was waived.

### Study population

All patients in the mixed ICU of the University Medical Center Utrecht who were discharged in the study periods were eligible; the migration from the old ICU to the newly built environment was on March 1st, 2010. Exclusion criteria were admission and discharge on the same day for survivors or within 48 h for non-survivors, cross-over from the old to the new ICU and readmission to the ICU after the study period.

### Intervention

The old 32 multi-bed ward ICU consisted of wards with 10–14 beds (12 $m^2$ per bed) with no window view (Table 1). The design of the wards allowed for simultaneous monitoring of multiple patients, and for direct communication between staff.

The new ICU consists of 36 noise-reduced, single rooms (each 25 $m^2$) with large windows and use of comfortable materials. Workflow was reorganised, and included the possibility for visual display of other patients via the bedside monitor. A satellite pharmacy at the ICU prepared medication, thereby reducing medication errors [22].

### Data collection

To determine satisfaction with care, we used the family satisfaction with care in the intensive care unit survey (FS-ICU 34©) [23], which was developed and validated for assessing family satisfaction with overall ICU experience [4, 7]. We performed a cross-cultural adaptation, evaluating translation and cultural adaptation of the survey [24, 25]. The original, English FS-ICU 34© [23] was translated to Dutch (I.P.J., D.v.D., H.W.) and subsequently back-translated to English by a native speaker. Discrepancies in translation were resolved through discussion.

Since we were particularly interested in satisfaction with ICU environment, we added two questions concerning environmental aspects (Supplementary Material 1). The additional items were integrated into the original FS-ICU categories, and divided over two parts: satisfaction with care (part I, containing 21 questions) and satisfaction with decision-making (part II, containing 16 questions).

In order to measure patient satisfaction with ICU experience, we developed an abbreviated form of the survey, focussing on items that were directly related to patient care [6]. The items for this patient satisfaction with care in the intensive care unit survey (PS-ICU, see Supplementary Material 2) were selected by the researchers (I.P.J., D.v.D., H.W., C.M.R., M.M.S.) and ultimately contained 19 items, again divided over two subscales: "care" and "decision-making".

In surviving patients, the FS-ICU (to hand over to the primary family member) and PS-ICU (to be filled in by the patient) were sent to the patient, 10 weeks after discharge from the ICU. When both patient and family did not respond, a reminder was sent after 4 weeks. In non-

**Table 1** Characteristics of ICU before and after migration

| | Before | After |
|---|---|---|
| Environment | 32 beds of which 24 on ward<br>12 $m^2$ per bed<br>Noisy, artificial light, no view | 36 beds<br>25 $m^2$ per bed<br>Noise reduced, daylight, view outside |
| Patient population | Mixed | Mixed |
| Nurse–patient ratio per day | 4.4 to 1 | 4.4 to 1 |
| Workflow | Simultaneous monitoring, direct staff interaction, materials and medication partly next to patient, preparation of medication by nurses | Monitoring via screen, alarms set to pagers, materials and medication in patient room, preparation of medication by satellite pharmacy |
| Family rooms | Four rooms, no window, shared bathroom facilities | Six rooms with window and bathroom |
| Waiting room | Outside unit, with coffee automat | Outside unit, with vending machines and internet |

survivors, the FS-ICU was sent to the family 10 weeks after the patient died in or was discharged from the ICU. No reminders were sent to family of non-survivors.

The surveys were labelled with a study number, to be able to link them to patient characteristics from the patient data management system (MetaVision®; iMDsoft, Leiden, The Netherlands). Characteristics of family respondents were provided via the survey. Data were stored and analysed anonymously.

## Validity of surveys

Validity, including face and content validity, has been demonstrated previously for the original FS-ICU, as well as for the German translation [4, 7, 26]. However, since we translated the survey and added two items, we assessed internal consistency by calculating Cronbach's alpha ($\alpha$), thereby evaluating the extent to which the different items of a subscale or total scale measure the same concept [27, 28]. For this analysis, we excluded three FS-ICU items with >60 % missing data (spiritual support, social work and pastoral care). We found $\alpha = 0.96$ for both FS-ICU and PS-ICU (Supplementary Table III). Furthermore, we examined the corrected item-total correlation, thereby analysing the correlation of one item and the sum score of the other items in a subscale. For one item in the FS-ICU, the corrected item-scale correlation was weak (<0.30): "hope recovery patient". Therefore, this item was removed from subscale and overall analysis [27]. In PS-ICU, all items had corrected item-scale correlation >0.30 and were included in the analyses.

## Statistical analysis

For family satisfaction with overall ICU experience (primary outcome), we calculated a sample size. Based on previous studies we assumed that family satisfaction with overall ICU experience would be rated 75 % [4, 8, 11, 26], and hypothesized that improvement of environment could increase satisfaction to 80 % (small effect of environment) [11]. Therefore, we needed 175 patients in each study period, with $\alpha = 0.05$ and $\beta = 0.80$. With the number of admissions of >2,000 per year and an expected non-response rate of 50 % [7, 10, 26], we planned 2 months of data collection per study period.

Descriptive analyses were used to summarize demographic characteristics of patients [age, gender, acute physiology and chronic health evaluation (APACHE) IV score, admission diagnosis, length of ICU stay, length of hospital stay, survival status] and of family respondents (age, gender, relation to patient).

Scores on the FS-ICU and PS-ICU were computed according to the validated coding and scoring procedures of the original FS-ICU [4], and presented in percentages, with 100 % representing highest satisfaction and 0 % lowest satisfaction. The primary outcome, satisfaction with overall ICU experience, was calculated by averaging the available single items, provided that per individual ≥70 % of questions were answered [4]. Secondary outcome measures were scores on the subscales "satisfaction with care" and "satisfaction with decision-making".

Differences between the ward-like and single-room ICU in overall satisfaction were calculated by using two-sample $T$ tests, since data were normally distributed. Additionally, we used analysis of variance (ANOVA) tests to calculate differences in satisfaction ratings per month, comparing results in more detail before and after the migration. To determine importance of items for overall satisfaction, we calculated Spearman correlations. For satisfaction with overall ICU experience, linear regression analyses were used to estimate the change in satisfaction that was associated with the migration to the single-room ICU, and to adjust for possible confounding. It has been suggested that increased age [29], male gender [30], higher severity of illness [11, 30], longer length of stay [31] and need for mechanical ventilation [15] are associated with higher satisfaction rates, as well as family of non-survivors [8, 11]. Therefore, we included these

variables for adjustment. Multicollinearity was tested in advance, and all covariates were included ($r < 0.8$).

All statistical analyses were performed with IBM® SPSS® version 20 (IBM Corporation, Somers, NY). $p$-Value <0.05 was considered statistically significant.

## Results

During the study periods, 709 patients were discharged (376 from the ward-like ICU, 333 from the single-room ICU) (Fig. 1). Of these, 92 patients were excluded, mainly because of short length of stay (<24 h) or unknown address of family of non-survivors. In all, from 387 of 617 discharged patients (63 %) at least one survey (FS-ICU and/or PS-ICU) was returned. From 255 discharged patients, both patient and a family member returned the survey.

Family respondents returned 342 (55 %) of 617 FS-ICU surveys. On 19 of these surveys, all questions were left blank or marked "not applicable". In written comments, family stated that they were satisfied, or that they did not fill in the survey since their loved-one died. Therefore, 323 surveys were included in analysis. Most of the family respondents were female partners with a mean age of 55 years (Table 2).

Of 568 PS-ICU surveys sent to patients who survived, 328 (58 %) were returned. On 54 surveys all questions were marked "not applicable" or left blank, with a written explanation that the patient had no memory of ICU admission. Therefore, 274 PS-ICU surveys were included in quantitative analysis. Most patient responders were male, with median age of 63 years at time of ICU admission and a median length of ICU stay of 2 days (Table 2).

Responders had a slightly higher median APACHE IV score as compared with non-responders (49 [IQR 35–68] and 47 [IQR 33–58], respectively; $p = 0.04$). There were no significant differences in gender, age or length of ICU stay between responders and non-responders (Supplementary Table IV).

### Family satisfaction

Mean family satisfaction with overall ICU experience increased from 69.5 in the ward-like ICU to 74.1 in the single-room ICU ($p = 0.02$) (Table 3). Mean scores on subscale "care" increased, from 65.1 to 70.8, respectively ($p < 0.01$). Monthly satisfaction rates after migration were higher as compared with rates before migration, though not significantly ($p = 0.13$) (Fig. 2). The correlation between environmental items (items 15–18) and overall satisfaction was 0.65, 0.69, 0.60 and 0.57, respectively ($p < 0.001$). When focussing on single items, significant differences in ratings were found on items "atmosphere ICU", "visiting possibilities", "atmosphere waiting room" and "facilities waiting room" (all $p < 0.01$) and on items "emotional support", "courtesy toward family", "overall experience", "questions answered" and "amount of care", all in favour of the new ICU (all $p < 0.05$) (Supplementary Table V). After adjustment for possible confounders using linear regression analyses, family satisfaction was higher in the single-room environment as compared with the ward-like ICU [$\beta_{adj} = 5.5$, 95 % confidence interval (CI) 1.4–9.5, $p < 0.01$] (Table 4).

### Patient satisfaction

Mean patient satisfaction with overall ICU experience increased from 63.6 in the ward-like ICU to 69.6 in the single-room ICU ($p = 0.02$) (Table 3). On the subscale "care", mean ratings increased from 63.6 in the ward-like ICU to 70.3 in the single-room ICU ($p = 0.01$). Again, monthly satisfaction rates were higher after migration ($p = 0.11$) (Fig. 2). The correlation between the three environmental items and overall satisfaction was 0.73 ("atmosphere ICU"), 0.61 ("silence ICU") and 0.65 ("visiting possibilities") (all $p < 0.001$). Patients discharged from the new ICU rated the following items significantly higher as compared with the old ICU: "courtesy", "atmosphere ICU", "silence ICU" and "visiting possibilities" (all $p < 0.01$) and items "pain management", "staff recognizable" and "overall experience" (all $p < 0.05$) (Supplementary Table VI). After adjustment for possible confounders, patient satisfaction was still higher in the single-room ICU as compared with the ward-like ICU [$\beta_{adj} = 5.8$, 95 % CI 0.7–10.9, $p = 0.03$] (Table 4).

## Discussion

This is the first study to quantify the effect of ICU environment on both family and patient satisfaction. In both groups, satisfaction with overall ICU experience increased by 6 % in a new, single-room ICU, as compared with an old, ward-like ICU with multi-bed areas.

In our study, environmental aspects were strongly correlated with overall satisfaction, which is in agreement with other studies [11, 32]. The increase in satisfaction was slightly higher than hypothesized, and congruent with the suggestion that single rooms and environmental aspects, such as colour and lighting, improve overall satisfaction [9, 33, 34]. Furthermore, environment may have a positive impact on the burden of delirium and on family health, in reducing the likelihood of family post-traumatic stress or anxiety [35, 36].

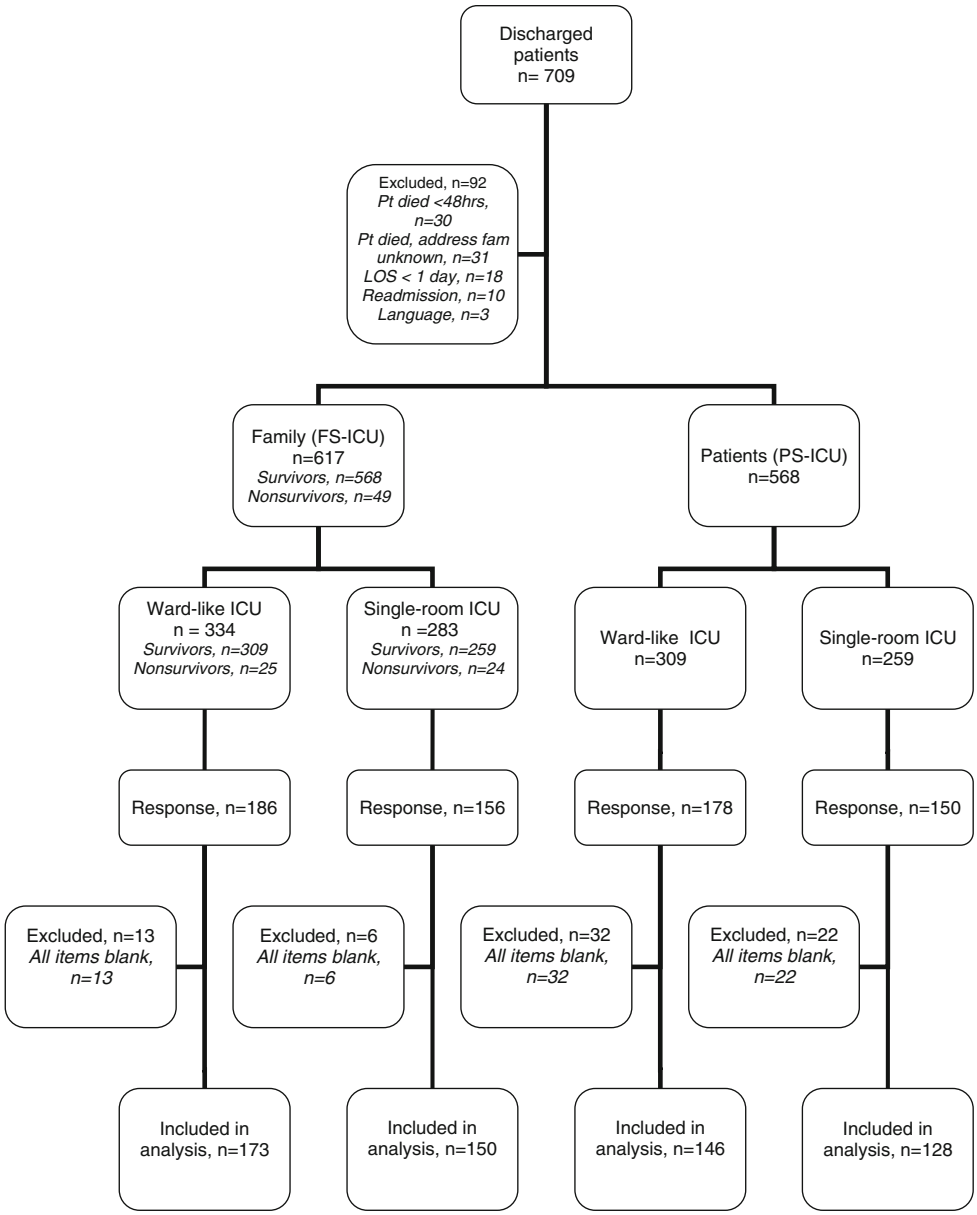


**Fig. 1** Flow diagram. *FS-ICU* family satisfaction in intensive care unit, *PS-ICU* patient satisfaction in intensive care unit, *LOS* length of stay, *ICU* intensive care unit, *pt* patient, *fam* family

As a consequence of the new setting, organisation of work flow, such as monitoring of patients and distribution of staff in the ICU, changed as well. Though staff may perceive a decreased ability to monitor multiple patients [37], simultaneous monitoring of patients was possible via visual display on the bedside monitor. Furthermore, since stocking of materials and medication was reorganised as well, nurse–patient ratios were comparable both before and after the migration.

As compared with other studies using the FS-ICU, satisfaction scores in our study were lower (72 versus 78–85 for our study and other studies, respectively) [4, 8, 11, 32]. This might be due to survey timing; we sent the surveys 10 weeks after discharge, while in most other studies surveys were distributed at discharge [4, 6, 7, 9, 10, 38]. It has been suggested that increasing time results in poorer satisfaction ratings, but results are not conclusive and consensus for timing of sending surveys has not been reached yet [29, 39, 40]. Another explanation for the difference in rating might be that this is due to cross-cultural or demographic differences [29]. Patients in our study had a shorter length of ICU stay (median 2 days as compared with 4–8 days), were more often admitted for cardiovascular reasons (where admission to ICU is often predictable) and were more likely to have their partner responding to the survey [4, 6, 8].

The use of a before–after design to study effect of migration to a new, single-room ICU was a natural

**Table 2** Characteristics of respondents

| | Family | | | Patients | | |
|---|---|---|---|---|---|---|
| | Ward-like ICU | Single-room ICU | $p$* | Ward-like ICU | Single-room ICU | $p$* |
| Respondents, *N* | 173 | 150 | | 146 | 128 | |
| Patient gender, *n* (%) male | 120 (69) | 94 (63) | 0.20 | 101 (69) | 84 (66) | 0.53 |
| Patient age in years, median (IQR) | 64 (55–71) | 61 (47–71) | 0.03 | 64 (56–72) | 62 (48–72) | 0.052 |
| APACHE IV score, mean (SD)[a] | 56 (29) | 52 (26) | 0.19 | 49 (19) | 46 (20) | 0.31 |
| MV within 24 h, *n* (%) yes | 163 (94) | 138 (92) | 0.43 | 134 (92) | 116 (91) | 0.74 |
| Admission after surgery, *n* (%) yes | 142 (82) | 115 (77) | 0.23 | 129 (88) | 108 (84) | 0.34 |
| Primary diagnosis, *n* (%) | | | 0.27 | | | 0.54 |
| Cardiovascular | 111 (64) | 82 (55) | | 102 (70) | 82 (64) | |
| Neurology/neurosurgery | 19 (11) | 25 (17) | | 13 (9) | 13 (10) | |
| Respiratory | 18 (10) | 17 (11) | | 15 (10) | 13 (10) | |
| Gastro-intestinal | 15 (9) | 11 (7) | | 12 (8) | 11 (9) | |
| Trauma/sepsis/other | 10 (6) | 15 (10) | | 4 (3) | 9 (7) | |
| ICU LOS in days, median (IQR) | 2 (2–5) | 2 (2–4) | 0.25 | 2 (2–4) | 2 (2–3) | 0.11 |
| Hospital LOS in days, median (IQR) | 10 (7–20) | 12 (8–22) | 0.25 | 10 (7–18) | 11 (8–18) | 0.60 |
| Patients survived (%) | 91 | 91 | 0.98 | | | |
| Age of relative, mean (SD) | 56 (12) | 55 (14) | 0.82 | | | |
| Gender of relative, *n* (%) male | 43 (25) | 45 (31) | 0.26 | | | |
| Relationship to patient, *n* (%) | | | | | | |
| Partner | 126 (74) | 102 (70) | 0.16 | | | |
| Parent | 6 (4) | 11 (8) | | | | |
| Child | 31 (18) | 20 (14) | | | | |
| Sibling | 6 (4) | 7 (5) | | | | |
| Other | 2 (1) | 6 (4) | | | | |

*ICU* intensive care unit, *IQR* inter-quartile range, *APACHE* acute physiology and chronic health evaluation, *MV* mechanical ventilation, *LOS* length of stay

* $p$-Value based on *T* tests (APACHE IV, age of relative), Mann–Whitney tests (patient age, length of stay) or $\chi^2$ tests (gender, MV, admission, relationship)

[a] In patients 25 APACHE IV scores are missing, in family 31 APACHE IV scores are missing

**Table 3** Comparison of mean (SD) family and patient satisfaction scores, after patient discharge from the ward-like ICU and single-room ICU

| | Family | | | Patients | | |
|---|---|---|---|---|---|---|
| | Ward-like ICU | Single-room ICU | $p^{\dagger}$ | Ward-like ICU | Single-room ICU | $p^{\dagger}$ |
| Total satisfaction | 69.5 (16.6) | 74.1 (15.2) | 0.02 | 63.6 (18.9) | 69.6 (18.3) | 0.02 |
| Subscale "satisfaction with care" | 65.1 (17.8) | 70.8 (18.0) | 0.007 | 63.6 (18.6) | 70.3 (18.2) | 0.01 |
| Subscale "satisfaction with decision-making" | 74.9 (17.4) | 78.0 (14.4) | 0.12 | 64.9 (20.4) | 68.5 (20.8) | 0.21 |

Family satisfaction: three items removed due to >60 % missing (items 5, 13, 14) and one item removed due to corrected item-total correlation <0.30 (item 31)

$^{\dagger}$ $p$-Value based on *T* tests

experiment, with potential threats to validity. One of the limitations is the risk of selection bias. The response rate was 55 and 58 % for family and patients, respectively. This is in line with other studies that used the FS-ICU, which had response rates of 28–74 % [7, 8, 16, 26, 32, 38, 41]. It has been suggested that people are more likely to respond when they have strong feelings, either positive or negative, and that older respondents are generally more satisfied [29]. However, we compared patient characteristics of responders and non-responders and did not find differences.

We performed a cross-cultural adaptation of the FS-ICU 34©. In the original survey and in a German translation, validity was considered satisfactory [4, 7, 26]. Therefore, we did not further validate the Dutch FS-ICU, nor did we pretest and validate the PS-ICU.

We did not take into account staff satisfaction. The migration might have influenced staff satisfaction, either positively (new environment with reduced noise levels, daylight and more space) or negatively (change in routine, reduced possibilities for staff communication). However, there is no evidence yet to support or refute the impact of

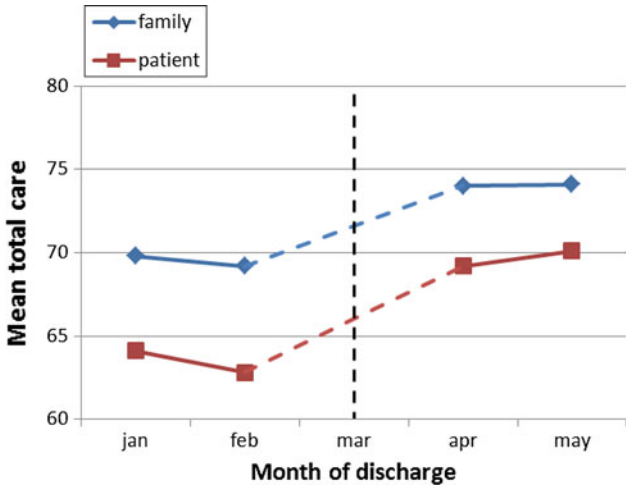


**Fig. 2** Mean satisfaction ratings per month: January and February, multi-bed ICU; April and May, single-bed ICU

**Table 4** Linear regression analyses of satisfaction with overall ICU experience

| | Family | | Patients | |
|---|---|---|---|---|
| | Adjusted $\beta$[a] | 95 % CI | Adjusted $\beta$[a] | 95 % CI |
| ICU environment | 5.5 | 1.4–9.5 | 5.8 | 0.7 to 10.9 |
| Patient gender | 1.1 | −3.1 to 5.4 | 1.0 | −4.5 to 6.5 |
| Patient age | −0.04 | −0.2 to 0.1 | 0.1 | −0.2 to 0.2 |
| APACHE IV score | 0.1 | −0.02 to 0.2 | 0.03 | −0.1 to 0.2 |
| Mechanical ventilation | −3.1 | −11.6 to 5.5 | −2.8 | −9.1 to 9.9 |
| Length of ICU stay | −0.1 | −0.6 to 0.3 | −0.2 | −1.1 to 0.8 |
| Survival | −1.3 | −9.9 to 7.4 | | |

*CI* confidence interval, *ICU* intensive care unit, *APACHE* acute physiology and chronic health evaluation, *LOS* length of stay

[a] Adjusted $\beta$: adjusted for all other items in the table

environment on work-related outcomes in healthcare staff [42].

The increase in satisfaction in both family and patients could potentially be attributed to other factors, such as secular trends or seasonal effects. Secular trends, i.e. improvements over time unrelated to the intervention, may not be feasible, since we covered a short period of time (5 months) and neither staffing nor protocols changed between settings. Besides, breaking up the data into four monthly periods revealed a change between February and April, when the ICU migrated. Since study periods covered different seasons (winter and spring), it might be possible that seasonal effects influenced satisfaction ratings. However, the effect of season on satisfaction ratings has not been identified so far.

As a strength, this is one of the few studies showing that both family and patient satisfaction are associated with an intervention, and therefore responsive to change. In cancer patients, effect of educative interventions on satisfaction has been studied, and though both patients and family seemed more satisfied, results have not been conclusive so far [43–45]. As far as we know, responsiveness of family and patient satisfaction to an intervention in ICU has never been studied before.

This study demonstrated that environment is an important factor in family and patient satisfaction, and that a single-room design improves satisfaction as compared with an ICU with multiple beds on a ward. When considering redesigning an ICU, a single-room design should be preferred.

## Conclusions

This is the first study to quantify the effect of ICU environment on both family and patient satisfaction, within a migrating ICU including a change in workflow, but with unaltered nurse–patient ratios, physician staffing and protocols. We demonstrated that family and patient satisfaction with ICU experience increased by 6 %, respectively, in the new ICU environment consisting of noise-reduced, single rooms with daylight, adapted colouring and improved family facilities.

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**Conflicts of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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