

Evaluation report of pediatric intensive care units in Turkey

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Background/aim: To collect data from throughout Turkey in order to facilitate the organization of pediatric intensive care units (PICUs), and to develop short-term immediate action plans and draft long-term strategic plans.

Materials and methods: A total of 35 specialists including 17 pediatric critical care (PCC) specialists, 9 PCC fellows in training, and 9 pediatricians working in PICUs evaluated PICUs and their infrastructures, mortality rates, appropriateness of indications for PICU admissions, PICU bed numbers, and utilization of those PICU beds.

Results: PICU bed numbers, PCC specialist numbers, and PICU nurse numbers are insufficient in Turkey. The high percentage of inappropriate and inefficient use of current PICU beds is also another problem.

Conclusion: In the light of this report, it is obvious that pediatric intensive care services are successful and efficient only in the presence of PCC specialists in PICUs. Studies for improving the infrastructure of PICUs and the training of PCC specialists and other health personnel should be started immediately.

Key words: Pediatric intensive care unit, regionalization

1. Introduction

This study aimed to collect data from throughout Turkey in order to facilitate the organization of pediatric intensive care units (PICUs). Infrastructures, mortality rates, appropriateness of indications for PICU admissions, PICU bed numbers, and utilization of those PICU beds were evaluated. This study intended to develop short-term immediate action plans and draft long-term strategic plans.

2. Materials and methods

A total of 35 specialists including 17 pediatric critical care (PCC) specialists, 9 PCC fellows in training, and 9 pediatricians working in PICUs evaluated PICUs between 7 and 30 June 2012. Two forms were used for standard evaluation. All forms were gathered together at the Ministry of Health Department of Health Services, Inspection, and Evaluation.

Form 1 was developed to assess the structure and staffing of the PICUs. Data about the number of PICU beds, total bed number for pediatric patients in the

hospital, bed occupancy rate for PICU and other pediatric wards, number of PCC specialists, number of nurses in the PICU and other pediatric wards, and number of PICU beds per nurse were collected in this form.

Form 2 was used to collect patient data. Charts of all patients who were admitted to PICUs during the time of the evaluation were reviewed. Additionally, half the number of beds in that unit was determined, and that number of patient charts were randomly selected and retrospectively reviewed from the medical archives. Data regarding patients' age, sex, diagnosis, length of stay, level of critical care received, place where they were transferred from, Pediatric Risk of Mortality Score (PRISM) 24, whether they were on mechanical ventilation or continuous intravenous vasoactive medication infusion, vital signs, mental status changes, severity of organ dysfunction, presence of intoxication, terminal illness, need for chronic medical care at home, level of intensive care that the patient needed, level of intensive care the patient received, and, if the level of intensive care the patient received was not appropriate,

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the reason for receiving inappropriate care were collected in this form. Forty-five days after the evaluation of units, deaths in those units and the reasons for death were also collected. Data from a total of 647 patients were collected and a crude mortality rate was calculated for those patients. Standard mortality rate (SMR) was calculated from the 448 patients whose PRISM 24 scores were available.

Population data regarding pediatric age groups were gathered from the Turkish Statistical Institute database. These data were used to calculate PICU bed number, pediatric critical care specialist numbers, and pediatric critical care nurse numbers per given population. PICUs included in the study were grouped into categories of Ministry of Health vs. university-affiliated units and those with and without PCC specialists. Those groups were compared for PICU bed numbers, PICU occupancy rate, sources patients transferred from, percentage of patients on mechanical ventilation or requiring continuous intravenous vasoactive infusion, patients with severe derangement of vital signs, organ system dysfunction/failure, terminal illnesses, patients requiring chronic care at home, and rate of inappropriate PICU admissions. Statistical analyses were completed by the Ministry of Health Department of Health Services, Inspection, and Evaluation. SPSS was used in all statistical analyses.

3. Results

3.1. Unit characteristics

3.1.1. Beds

- There were a total of 63 centers providing PCC in Turkey (Figure 1).
- There were a total of 602 PICU beds, including 227 level 2 PICU beds and 375 level 3 PICU beds. Forty-four of the 63 centers provided level 3 critical care

services. One hundred and forty-seven of the level 3 PICU beds were staffed with PCC specialists (Figures 2 and 3).

- Twenty-seven Ministry of Health-affiliated centers had 283 (47%) PICU beds and 36 university-affiliated hospitals had 319 (53%) PICU beds (Figure 4).
- PICU beds were distributed as follows: 37 (6.1%) in Ministry of Health-affiliated centers with PCC specialists, 246 (40.9%) in Ministry of Health-affiliated centers without PCC specialists, 152 (25.3%) in university-affiliated centers with PCC specialists, and 167 (27.7%) in university-affiliated centers without PCC specialists (Table 1).
- According to the Turkish Statistical Institute's 2011 data, the population of the 0–18 years age group was 23,979,272, which resulted in 39,832 children per PICU bed.
- The number of children per level 3 PICU bed was 63,944.
- The rate of PICU beds to total pediatric beds was calculated as 7.5%.
- The total occupancy rate of PICU beds was 79.3% during the period of data collection.
- The bed occupancy rate of PICU beds was found to be 88% in Ministry of Health-affiliated hospitals, whereas it was 66.1% in university-affiliated hospitals ($P < 0.05$).
- The bed occupancy rate was 86% in PICUs with a PCC specialist and was 76% in PICUs without a PCC specialist ($P < 0.05$).
- Bed occupancy rates were as follows: 88% in Ministry of Health-affiliated hospitals with a PCC specialist, 83% in Ministry of Health-affiliated hospitals without a PCC specialist, 72% in university-affiliated centers with PCC specialists, and 61% in university-affiliated centers without PCC specialists (Table 1).



Figure 1. Pediatric intensive care units in Turkey.

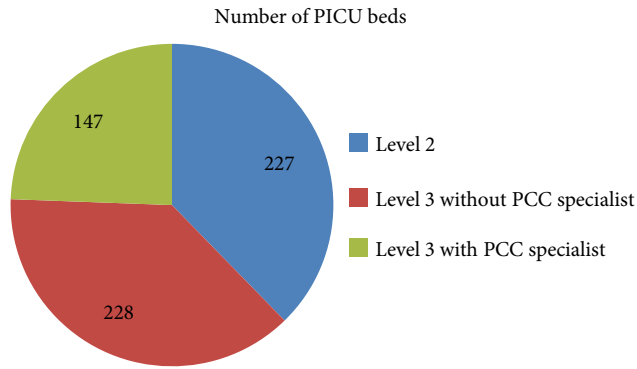


Figure 2. Distribution of beds: level 2 and level 3, with and without a PICU specialist.

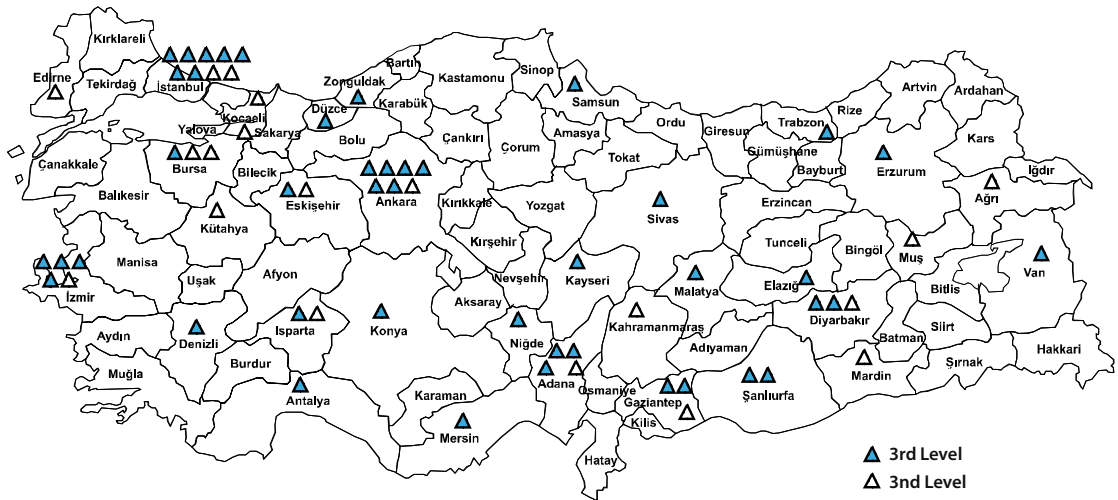


Figure 3. Level of care by center.



Figure 4. Distribution of PICUs: university-affiliated hospitals and hospitals affiliated with the Ministry of Health.

Table 1. Bed numbers, occupancy rates, patient characteristics, inappropriate admissions, and mortality rates for each center.

	Ministry of Health-affiliated hospitals		University-affiliated hospitals		
	With a PCC specialist	With a PCC specialist	With PCC Specialist	Without a PCC specialist	
Number of beds	37 (6.1%)	246 (40.9%)	152 (25.3%)	167 (27.7%)	
Occupancy rate	88%	83%	72%	61%	(P < 0.05)
Mechanically ventilated patients	48.6%	38.4%	65.6%	39.2%	(P < 0.05)
Patients with severe derangement in vital signs	56.7%	51.4%	80.1%	40.2%	(P < 0.05)
Patients on vasoactive medication infusion	34.2%	70.1%	84.2%	66%	(P < 0.05)
Patients with at least 1 organ system failure	56.8%	57.8%	87.4%	53.2%	(P < 0.05)
Inappropriate PICU admissions	16.2%	21.8%	4.7%	16.4%	(P < 0.05)
112 (other hospital)	17.6%	23.5%	38.1%	25.1%	(P < 0.05)
Crude mortality rate	11.1%	14.2%	19.6%	17.4%	(P < 0.05)
Standard mortality rate	0.8	0.96	0.65	0.86	(P < 0.05)

3.1.2. Specialists

- There were a total 19 PCC specialists. Three of those specialists were working at Ministry of Health-affiliated centers and 16 of them were working at university-affiliated hospitals (Figure 5).
- The total number of fellows in PCC medicine training was 9. The 17 PCC medicine fellowship positions that were opened in the 2012 Subspecialty Examination had not started fellowship training yet.
- The number of PICU beds per PCC specialist was 31.7.

3.1.3. Nurses

- There were a total of 811 PICU nurses.
- Four hundred and fifty-four (56%) of those nurses worked in Ministry of Health-affiliated centers, whereas 357 (44%) of nurses work in university-affiliated centers.

- In general, the number of nurses per PICU bed was 1.34. This ratio was 1.6 and 1.1 in Ministry of Health-affiliated hospitals and university-affiliated hospitals, respectively.
- The number of PICU beds per nurse during shifts was 1.99–3.5 and 1.96–3.9 in Ministry of Health-affiliated hospitals and university-affiliated hospitals, respectively.

3.2. Patient characteristics

- In total, 720 patients were evaluated for the study. Four hundred and thirty-one of those were admitted to PICUs at the time of data collection. Data of an additional 289 patients were also collected retrospectively from their medical charts.
- Forty-five percent of patients were female and 55% were male.

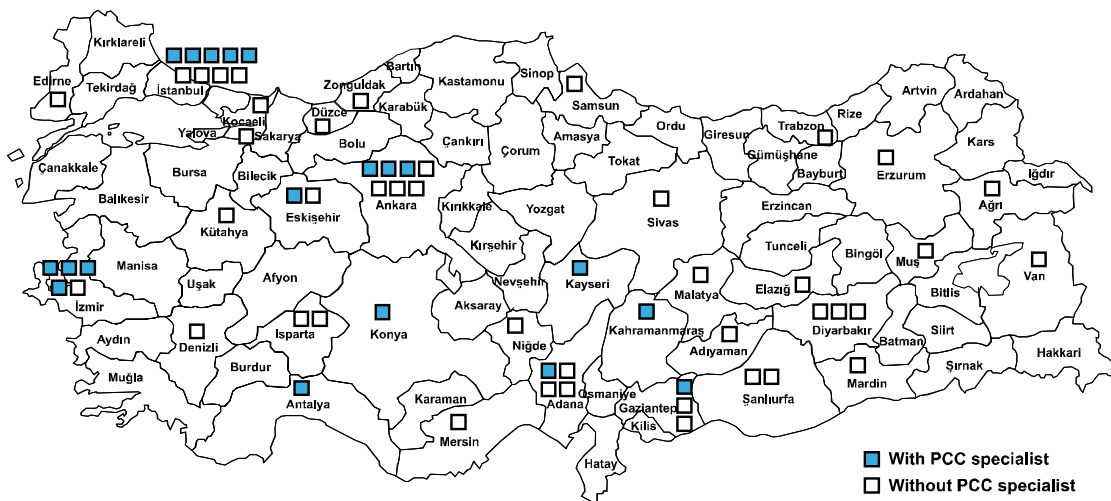


Figure 5. Distribution of centers with and without a PICU specialist.

- The age distribution of patients was as follows: 58% 0–2 years of age, 18% 3–6 years of age, 12% 7–12 years of age, 12% 13–18 years of age ($P < 0.05$; Figure 6).
- Three hundred and eighty-two (53%) patients were admitted to Ministry of Health-affiliated hospitals and 338 (47%) of patients were admitted to university-affiliated hospitals.
- Three hundred and forty-five (48%) of patients were admitted to level 2 PICUs and 375 (52%) patients were admitted to level 3 PICUs.
- The distribution of length of stay of patients was: 0–2 days for 23% of patients, 3–7 days for 25% of patients, 8–14 days for 15% of patients, and longer than 14 days for 37% of patients. Fifty-two percent of patients stayed in PICU longer than 7 days ($P < 0.05$; Figure 7).
- The distribution of diagnosis of patients was: 29% respiratory problems, 25% neurological diseases, 8% cardiac illnesses, 8% intoxications, 8% infectious diseases, 4% trauma-related conditions, 4% metabolic diseases, 4% gastrointestinal illnesses, 3% burns, 3% renal diseases, 1% oncologic diseases, and 1% hepatological, 1% endocrinological, and 1% other illnesses (Figure 8).
- In centers affiliated with the Ministry of Health, 61.7% of PICU patients were admitted from the same hospital's emergency department or general pediatrics wards, 22.5% of PICU patients were transferred via national emergency call (112) services from other hospitals, and 15.8% of patients were transferred via 112 services from patients' homes. In centers affiliated with universities,

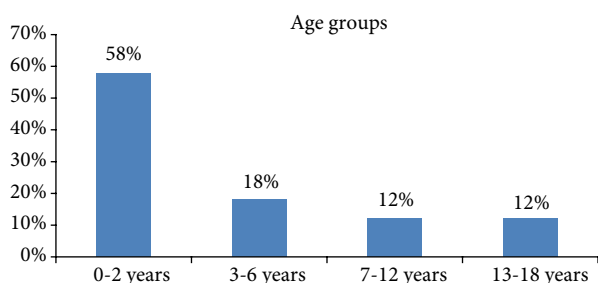


Figure 6. Age distribution of patients.

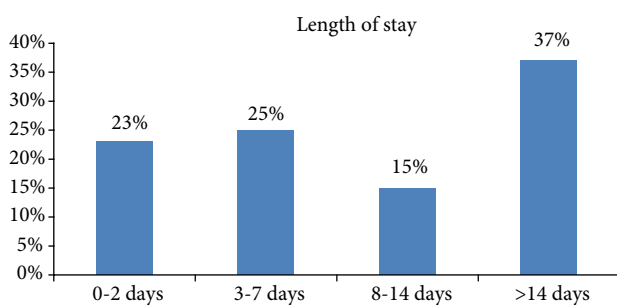


Figure 7. Length of stay in PICUs.

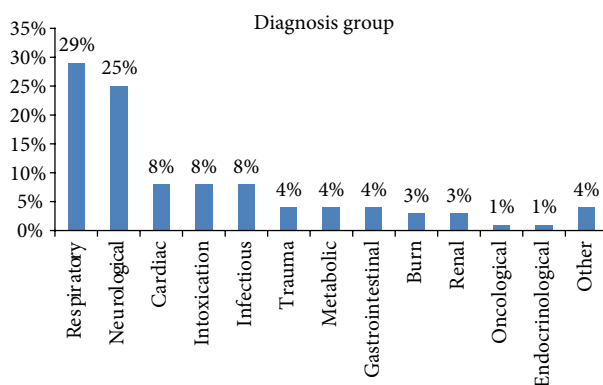


Figure 8. Reason for admission to PICU.

60.6% of PICU patients were admitted from the same hospital's emergency department or general pediatrics wards, 33% of PICU patients were transferred via 112 services from other hospitals, and 6.4% of patients were transferred via 112 services from patients' homes. The difference in source of admission to PICU between Ministry of Health-affiliated hospitals and university-affiliated hospitals was statistically significant ($P < 0.05$).

- PICUs with a PCC specialist admitted 38.6% of their patients from other hospitals via 112 services, 54.2% of patients from the same hospital's emergency department or general pediatrics wards, and 7.2% of patients from patients' homes via 112 services. PICUs without a PCC specialist admitted 22.8% of their patients from other hospitals via 112 services, 64.4% of patients from the same hospital's emergency department or general pediatrics wards, and 12.8% of patients from patients' homes via 112 services. The difference in source of admission to PICUs between centers with and without PCC specialists was statistically significant ($P < 0.05$).
- Centers affiliated with the Ministry of Health that had a PCC specialist admitted 82.4% of patients from the same hospital's emergency department or general pediatric wards and 17.6% of patients from other hospitals via 112 services.
- Centers affiliated with the Ministry of Health that did not have a PCC specialist admitted 56.4% of patients from same hospital's emergency department or general pediatric wards, 20.1% of patients from home via 112 services, and 23.5% of patients from other hospitals via 112 services.
- PICUs with a PCC specialist in university-affiliated hospitals admitted 48.2% of patients from the same hospital's emergency department or general pediatric wards, 16.4% of patients from home via 112 services, and 38.1% of patients from other hospitals via 112 services.

- PICUs without a PCC specialist in university-affiliated hospitals admitted 68.2% of patients from the same hospital's emergency department or general pediatric wards, 6.7% of patients from home via 112 services, and 25.1% of patients from other hospitals via 112 services (Table 1).

3.3. Severity of illness

- Forty-six percent of all patients were mechanically ventilated. Forty-one percent of patient in PICUs affiliated with the Ministry of Health were mechanically ventilated, while 52% of patients in PICUs affiliated with universities were ($P < 0.05$).
- The percentage of patients mechanically ventilated was 61.6% in PICUs with a PCC specialist and 40.4% in other PICUs ($P < 0.05$).
- The percentage of patients mechanically ventilated was 48.6% in centers affiliated with the Ministry of Health that had a PCC specialist, 38.4% in centers affiliated with the Ministry of Health that did not have a PCC specialist, 65.6% in university-affiliated PICUs with a PCC specialist, and 39.2% in university-affiliated PICUs without a PCC specialist ($P < 0.05$; Table 1).
- Seventy percent of all patients were on continuous intravenous vasoactive medications. The percentage of patients on continuous intravenous vasoactive medications in Ministry of Health-affiliated hospital PICUs was 65%, whereas it was 75% in university-affiliated hospital PICUs ($P < 0.05$).
- The percentage of patients on continuous intravenous vasoactive infusion was 76.1% and 68% in PICUs with and without a PCC specialist, respectively ($P < 0.05$).
- The distribution of patients on continuous intravenous vasoactive infusion was as follows: 34.2% in centers affiliated with the Ministry of Health with a PCC specialist, 70.1% in centers affiliated with the Ministry of Health without a PCC specialist, 84.1% in university-affiliated PICUs with a PCC specialist, and 66% in university-affiliated PICUs without a PCC specialist ($P < 0.05$) (Table 1).
- Severe derangement of vital signs was found in 53.4% of all patients. The percentage of patients with severe derangement of vital signs was 53.1% and 54.6% in Ministry of Health-affiliated hospital PICUs and university-affiliated hospital PICUs, respectively ($P < 0.17$).
- The percentage of patients with severe derangement of vital signs was 72.4% and 45.2% in PICUs with and without a PCC specialist, respectively ($P < 0.05$).
- The distribution of patients with severe derangement of vital signs was as follows: 56.7% in centers affiliated with the Ministry of Health that had a PCC specialist, 51.4% in centers affiliated with the Ministry of Health that did not have a PCC specialist, 80.1% in

university-affiliated PICUs with a PCC specialist, and 40.2% in university-affiliated PICUs without a PCC specialist ($P < 0.05$; Table 1).

- At least 1 organ system failure was found in 65.1% of all patients. The percentage of patients with at least 1 organ system failure was 58% and 71% in Ministry of Health-affiliated hospital PICUs and university-affiliated hospital PICUs, respectively ($P < 0.05$).
- The percentage of patients with at least 1 organ system failure was 84.5% and 54.2% in PICUs with a PCC specialist and other hospitals, respectively ($P < 0.05$).
- The distribution of patients with at least 1 organ system failure was as follows: 56.6% in centers affiliated with the Ministry of Health with a PCC specialist, 58.1% in centers affiliated with the Ministry of Health without a PCC specialist, 87.4% in university-affiliated PICUs with a PCC specialist, and 53.2% in university-affiliated PICUs without a PCC specialist ($P < 0.05$; Table 1).
- Ten percent of all patients had terminal illnesses. The percentage of patients with terminal illnesses was equal at 10% in both Ministry of Health-affiliated hospital PICUs and university-affiliated hospital PICUs.
- Forty-two percent of all patients required chronic medical care with 24% of those needing care at home.

3.4. Appropriateness of PICU admissions

- Twenty-nine percent of patients under level 2 care and 33% of patients under level 3 care were found to be inappropriately admitted according to the PICUs level of care.
- It was found that 19% of patients under level 2 care were unnecessarily admitted to PICUs, and 10% of level 2 patients required level 3 care.
- It was found that 11% of patients under level 3 care were unnecessarily admitted to PICUs, and 22% of level 3 patients required level 2 care.
- The overall unnecessary admission rate to PICUs was 14.8%. Percentage of unnecessary PICU admission was 20.1% and 9.8% in Ministry of Health-affiliated hospital PICUs and university-affiliated hospital PICUs, respectively ($P < 0.05$).
- The percentage of unnecessary PICU admission was 6.1% and 19.2% in PICUs with a PCC specialist and other hospitals, respectively ($P < 0.05$).
- The distribution of unnecessary PICU admissions was as follows: 16.2% in centers affiliated with the Ministry of Health with a PCC specialist, 21.8% in centers affiliated with the Ministry of Health without a PCC specialist, 4.7% in university-affiliated PICUs with a PCC specialist, and 15.2% in university-affiliated PICUs without a PCC specialist ($P < 0.05$; Table 1).

3.5. Mortality rates

- One hundred and five (16.2%) patients died among 647 patients with available mortality data.

- The crude mortality rate was 13.9% and 18.6% in Ministry of Health-affiliated hospital PICUs and university-affiliated hospital PICUs, respectively ($P < 0.05$)
- The crude mortality rate was 18.2% and 15.1% in PICUs with a PCC specialist and other hospitals, respectively ($P < 0.05$).
- The crude mortality rate was 11.1% in centers affiliated with the Ministry of Health that had a PCC specialist, 14.2% in centers affiliated with Ministry of Health that did not have a PCC specialist, 19.6% in university-affiliated PICUs with a PCC specialist, and 17.4% in university-affiliated PICUs without a PCC specialist ($P < 0.05$; Table 1).
- The SMR (observed mortality/expected mortality) calculation with PRISM scores was found to be 0.8 in all patients.
- The SMR was 0.83 and 0.75 in Ministry of Health-affiliated hospital PICUs and university-affiliated hospital PICUs, respectively. No statistically significant difference was found ($P = 0.3$).
- The SMR was 0.71 and 0.92 in PICUs with a PCC specialist and other hospitals, respectively ($P < 0.05$).
- The SMR was found to be 0.8 in centers affiliated with the Ministry of Health that had a PCC specialist, 0.96 in centers affiliated with the Ministry of Health that did not have a PCC specialist, 0.65 in university-affiliated PICUs with a PCC specialist, and 0.86 in university affiliated PICUs without a PCC specialist ($P < 0.05$) (Table 1).
- The distribution of patients who died by age groups was 62% at 0–2 years of age, 12% at 3–6 years of age, 14% at 7–12 years of age, and 12% at 13–18 years of age.
- The mortality rates for age groups were 17% at 0–2 years of age, 10% at 3–6 years of age, 19% at 7–12 years of age, and 17% at 13–18 years of age ($P = 0.26$).
- Fifty-five percent and 45% of all deaths were males and females, respectively.
- Mortality rates were found to be 12.8% and 20% in males and females, respectively. No statistically significant difference was found ($P = 0.19$).
- Thirty-nine percent of patients who died in all PICUs were found to have terminal illnesses. Crude mortality rate was 64% and 11% in patients with and without terminal illnesses, respectively ($P < 0.05$).

4. Discussion

PCC services are very important elements of health care services in developed countries. It is estimated that mortality rates in children would be doubled without PCC services (1).

4.1. PICUs and bed numbers

When compared to 337 PICUs in the United States as of 2005, Turkey's total 63 PICUs nationwide appears not to be sufficient (2). This study was helpful in regards to assessment of our PICUs, not only quantitatively but also qualitatively. Qualitative analyses showed that just increasing the number of PICUs or PICU beds would not be an optimal solution to the current problem.

It is estimated that number of children per PICU bed is 1:27,000 to 1:50,000 (3–5). The total PICU bed number in Turkey was found to be 602, including 227 beds in level 2 centers and 375 in level 3 centers. Based on those numbers, Turkey's PICU bed number per child was found to be 1:39,382. However, this number increases to 63,944 when only level 3 care PICU beds are considered. In order to provide a level 3 PICU bed per child ratio of 1:40,000, Turkey needs a total of 597 level 3 PICU beds.

The overall PICU occupancy rate was found to be 79% during the study period. Considering the need for PICU beds, this level of occupancy should be considered high. In PICUs staffed with a PCC specialist, the occupancy rate was 86%; on the other hand, in PICUs without a PCC specialist, the occupancy rate was 76%. These findings support the theory that PICUs with PCC specialists are used more efficiently.

The percentage of PICU beds among total beds for the pediatric age group was 7.5%. This percentage is lower than it needs to be. Between 1980 and 2000, bed numbers for general pediatrics declined by 40% in Turkey, whereas PICU beds increased by 70% in the United States (1).

4.2. PCC specialists

There are 19 PCC specialists in 63 PICUs in Turkey. Three of those PCC specialists are working in Ministry of Health-affiliated PICUs and 16 of them are at university-affiliated hospitals. Only 30% of Turkey's PICUs are staffed with a PCC specialist. This percentage is 94% in United States, 98% in Europe, and 100% in Australia (6,7). In developed countries, it has been shown that the full-day presence of PCC specialist in PICUs improves mortality and treatment of PICU patients (8). Since the publication of studies showing decreased mortality in PICUs staffed with a PCC specialist, there has been an increased demand for PCC specialists (9–12).

The ratio of PCC specialist to PICU beds is 1:31.7 in Turkey. This ratio is very high when compared to developed countries. This ratio is 1:2–1:4.5 in the United States, 1:1.2–1:1.6 in Europe, and 1:3–1:5 in Australia (1,13). There are 4 PCC specialists for every PICU on average in the United States. In Australia, a staffing level of 5 PCC specialists for every 6–8 PICU beds is recommended (1,13). All of Turkey's PICUs with PCC specialists have only 1 PCC specialist per unit, except for 1 PICU. There are many studies confirming that decreased mortality is

associated with the presence of PCC specialists in PICUs (10,11,14,15). The ratio of PCC specialist per 100,000 children is 0.08 in Turkey. In some European countries, the number of PCC specialist per population is as much as 30 times higher than in Turkey (16).

If the target PICU bed number is 600, then a total of 400 PCC specialists will be needed to provide 24-h coverage for those PICU beds. Considering the graduation rate of PCC specialists based on open positions in the national Turkish specialization exam, it will take about 40 years to reach that goal (16).

It is a positive development that the PICU bed numbers increased from 123 in 2005 to 375 in 2012. However, the ratio of PCC specialists to PICU beds was 1:12 in 2005, and this ratio decreased to 1:32 in 2012. Those changes are clear indicators of the important crisis in PICUs (17). The increase in bed numbers was not supported by a parallel increase of PCC specialists, and this discrepancy can potentially result in increased PICU mortality and higher PICU costs with less quality and efficiency in patient care.

High occupancy rates, lower percentages of inappropriate admissions, and lower SMR in PICUs with PCC specialists are the indicators of more efficient use of those PICUs. Additionally, PICUs with a PCC specialist had a higher percentage of patients on mechanical ventilators and receiving intravenous vasoactive infusions, patients with severe derangement of vital signs and organ system failure, and patients who were transferred from other hospitals via 112 services. Those are also indicators of efficient use of PICUs with PCC specialists (Table 1).

PCC fellowship programs are among the most popular 3 fellowships in the United States and the total number of PCC specialists is in the top 5 among physician groups (18). In 2011, only 9 of 15 physicians who were accepted to PCC fellowship programs in the national Turkish specialization exam started their training. Being a PCC specialist is perceived as a very difficult lifestyle. In order to encourage more physicians to pursue a career in PCC medicine, there should be attractive financial advantages for PCC specialists. Otherwise, it will not be possible to train more PCC specialists even if there are more training programs.

4.3. PICU nurses

A total 822 nurses were working in PICUs, and the number of nurses per PICU bed was 1.34. The number of PICU beds per nurse during shifts was 1.99–3.5 and 1.96–3.9 in Ministry of Health-affiliated hospitals and university-affiliated hospitals, respectively. The average number of PICU nurses per PICU bed is about 1:2.9–3.2 and the best ratio of PICU nurses to PICU beds is 1:2 in the United States (2). In Europe, the recommended number of PICU nurses for each PICU bed is 6, and the nurse to patient ratio is 1:1 (13). In February of 2012, the Ministry of Health

stated that there must be at least 1 nurse for every 2 beds in PICUs all the time. Our findings show that Turkey is far from reaching that standard. The lowest ratio of nurses to PICU beds was 1:1.1 in university-affiliated hospitals.

More than 95% of PICUs in developed countries are staffed with nurses who are specifically trained for PICUs (6). Without considering the certification and length of experience of Turkey's current nurses, and accepting all nurses working in PICUs as PICU nurses, the significant deficit in the number of PICU nurses is very clear. If we aim to have 3 nurses for each PICU bed, at least 250 more nurses are immediately needed to cover the current level 3 PICU beds. When the desired number of PICU beds is reached, a total of 1800 nurses are going to be needed.

4.4. Patient characteristics in PICUs

Nearly half of the patients in this study were admitted to level 3 PICUs. The largest population among PICU patients was children between 28 days and 2 years old, and there were no significant differences between sexes (58% at 0–2 years of age, 18% at 3–6 years of age, 12% at 7–12 years of age, and 12% at 13–18 years of age). It is helpful to have the data about age distribution of PICU patients in order to choose the bed sizes in PICUs to be opened.

The distribution of diagnoses in PICU patients was: 29% respiratory problems, 25% neurological diseases, 8% cardiac diseases, 8% intoxications, 8% infectious diseases, 4% trauma-related conditions, 4% metabolic diseases, 4% gastrointestinal illnesses, 3% burns, 3% renal diseases, 1% oncologic diseases, and 1% hepatological, 1% endocrinological, and 1% other illnesses. These data should be applied when considering what other subspecialties should be present in hospitals with PICUs (Figure 8).

The percentage of PICU patients transferred from other hospitals by 112 services was 22.5% and 33% in Ministry of Health-affiliated and university-affiliated PICUs, respectively. Those results support the view that university-affiliated hospitals are providing more tertiary care compared to Ministry of Health-affiliated hospitals. The most important factor that determines patient transfer from other hospitals seemed to be the presence of a PCC specialist in PICUs. The percentage of patients transferred via 112 services from other hospitals was 38.6% and 22.8% in PICUs with and without a PCC specialist, respectively.

In general, 46% of patients were mechanically ventilated, 70% of patients were receiving continuous vasoactive medication infusion, 53.4% of patients had severe derangement of vital signs, and 65% of patients had at least 1 organ system failure. The percentage of patients on mechanical ventilators was 40.1% and 52% in Ministry of Health-affiliated and university-affiliated hospitals, respectively. There was a higher percentage of mechanically ventilated patients, patients on continuous vasoactive medication infusions, and patients with organ

system failure in university-affiliated hospitals compared to Ministry of Health-affiliated hospitals, which indicates that university-affiliated PICUs had sicker patients. PICUs are expected to provide medical services to critically ill children. A higher percentage of severely ill patients was found to be associated with the presence of a PCC specialist. In PICUs with a PCC specialist, 61.6% of patients were on mechanical ventilators, while 40.4% of patients were mechanically ventilated in other PICUs. Similarly, 72.4% of patients in PICUs with a PCC specialist had severe derangement of vital signs, whereas this percentage was 45.2% in PICUs without a PCC specialist. Considering the higher percentage of patients requiring mechanical ventilation and vasoactive medication infusion, and patients with severe derangement of vital signs and organ system failure, this indicates that university-affiliated PICUs with a PCC specialist are providing medical care to the most severely ill children (Table 1). However, those units where the sickest patients were admitted had the lowest nurse/PICU bed ratio, and this concerning paradox needs immediate attention.

4.5. PICU occupancy

Fifty-three percent of the study patients were in Ministry of Health-affiliated hospitals and 47% of were in university-affiliated hospitals. The Ministry of Health and university-affiliated hospitals were 2 comparable groups with comparable patient numbers in each.

The mean length of stay was longer than 7 days in 52% of patients and longer than 14 days in 37% of patients in PICUs. The higher percentage of patients with a long length of stay in PICUs may be considered as inappropriate PICU bed occupancy. The fact that 10% of all PICU patients had a terminal disease supports this conclusion. Similarly, 42% of all PICU patients were found to require chronic medical care, and 24% of those patients actually required care at home. One possible solution to ensure appropriate admissions to PICUs may be a central patient placement system where the patient's diagnosis and severity of illness score are taken into account while making decisions.

Twenty-nine percent of level 2 care and 33% of level 3 care admissions were found to be inappropriate. Nineteen percent of level 2 care patients did not need PICU admission and 10% of level 2 care patients needed level 3 care. Eleven percent of level 3 patients did not need PICU admission and 22% of level 3 care patients needed level 2 care. It was found that 14.8% of all patients in PICUs did not actually require PICU admission. The percentage of patients in PICU who actually did not require PICU admission was 20.1% and 9.8% in Ministry of Health-affiliated and university-affiliated PICUs, respectively. It was also noted that the percentage of patients in PICU who actually did not require PICU admission was 6.1% and 19.2% in PICUs with and without a PCC specialist,

respectively. The presence of PCC specialists in PICUs is an important parameter to consider in order to avoid wasting medical resources due to inappropriate PICU admissions. The lowest rate of inappropriate PICU admission was in university-affiliated PICUs with a PCC specialists (Table 1).

4.6. Mortality in PICUs

One hundred and five of 647 study patients died. The crude mortality rate was 16% in this study. PICU mortality has been reported as 2.9% in the United States (7), 5.6% in Europe (6), and 4% in Australia (19). On the other hand, the PICU mortality rates in developing countries such as South American countries, India, and South Africa have been reported as 18%–32% (20–22). It is reasonable to conclude that having a mortality rate of higher than 10% in PICUs of developing countries could be attributable to providing intensive medical care to patients with unfavorable prognosis or to patients without clear indications for PICU admission. The current study showed that 39% of patients who died had terminal diseases. Crude mortality rate was 64% in patients with terminal diseases, whereas it was 11% in patients without terminal diseases. Inappropriate admissions to PICUs lead to economic loss and prevent patients who actually need intensive care from having appropriate care for their illnesses. Inappropriate PICU admissions also make calculated mortality rates seem higher than the true mortality rates. Crude mortality rate calculations are not the most reliable indicators for assessment of quality of medical care. SMR calculations are used for this purpose. SMR is defined as the ratio of observed mortality rate to the expected mortality rate in a sample of patients in a given time interval. In our study, the PRISM 24 scoring system was used to estimate expected mortality rate and the SMR was found to be 0.8 in all patients. The SMR of 0.8 means that 8 of the 10 patients who were expected to die actually died in our cohort. It is very encouraging that the SMR was less than 1 in Turkey's PICUs. SMR is also a useful tool in order to follow and standardize the quality of medical care provided in PICUs. SMR was found to be lower in university-affiliated hospitals (SMR = 0.75) compared to Ministry of Health-affiliated hospitals (SMR = 0.83). However, a more significant difference was noted in the case of the presence of a PCC specialist in PICUs (Table 1). In another study conducted in Turkey, it was concluded that there was a 12 times higher mortality in lower risk patients and a 2 times higher mortality in higher risk patients in PICUs without a PCC specialist compared to PICUs with a PCC specialist (23). In our study, the SMR was 0.71 and 0.92 in PICUs with and without a PCC specialist, respectively. Those results confirm that the presence of PCC specialists in PICUs improved mortality (Table 1).

4.7. Recommendations

Existing PICU bed numbers are insufficient for the pediatric population in Turkey (Table 2). In the light of this report, it is obvious that pediatric intensive care services are successful and efficient only in the presence of PCC specialists in PICUs. Studies for improving infrastructure and training PCC specialists and other health personnel should be immediately started, and these studies should be pursued in a strategic and coordinated manner.

Developing regional centers is called 'regionalization' and this approach is the recommended PICU management model for countries with limited resources. Every country might have relatively limited PICU personnel and resources, and the regionalization model is applied by wealthy countries such as the United Kingdom and Australia. Respectable institutes including the Society of Critical Care Medicine in the United States, the British Association of General Paediatrics, the American Academy of Pediatrics, and the National Health and Medical Research Council in Australia recommend regionalization of PICUs (24–26).

When the currently existing PCC specialists and the training capacity of these specialists are considered, then 19 regional emergency-critical care centers (RECCCs) can potentially be built in Turkey. Planning regional centers via the 11 health service regions on the map of the Ministry of Health will facilitate the integration of this plan into the currently ongoing general health care system (Table 3; Figure 9).

In the long term, as the number of PCC specialists increases, 23 health service region maps and province-based health care maps can be evaluated for the construction of RECCCs. Because similar limitations are present for

pediatric emergency departments and these 2 disciplines are closely related to each other, this reconstruction system for PICUs should also include pediatric emergency rooms besides PICUs,

Addressing constructional deficiencies and training new PCC specialists are 2 processes that should be pursued parallel to each other. Because the number of existing specialists is already inadequate for current PICU beds, priority should be given to overcoming the specialist deficit.

4.7.1. First region

The pediatric population in this region is 2,160,560. Since the PICU bed/child ratio for this region is 1/102,883 and there is no PCC specialist, the construction of a RECCC in this region has the highest priority (Table 2). The existing number of tertiary PICU beds in this region is 21. According to the size of the pediatric population, the number of PICU beds needed is 54. It should be ensured that the bed number in a single RECCC does not exceed 40 beds. For this reason, in this region 2 RECCCs must be constructed and, after considering other subspecialties, these centers must be placed in Erzurum and Trabzon.

It is also important that PCC specialists should be employed when the construction of beds are completed. The education of the first PICU fellows who started in 2011 will have been completed in 1.5 years. This time seems to be enough for completing the infrastructure deficit. By this time, the 1st region must be supported by the adjacent 2nd, 3rd, 4th, and 5th regions.

Some of the doctors who have been actively working in PICUs could not be certified because of the 'having worked in a PICU for at least 5 years' rule when the PCC specialty was newly established. Now these doctors, who

Table 2. Number of children, centers, specialists, beds, patients per bed, and target number of beds for each health services area.

Region	Population of children	Number of centers	Number of PCC specialists	Number of PICU beds	People per level 3 PICU bed	Number of target PICU beds
1. Erzurum	2,160,560	5	0	21	102,883	54
2. Diyarbakır	2,122,951	5	0	26	81,651	53
3. Gaziantep	2,561,505	8	2	43	59,569	64
4. Adana	2,803,533	8	2	81	34,611	70
5. Samsun	864,007	1	0	10	86,400	22
6. Ankara	3,794,139	11	5	64	59,283	95
7. Antalya	779,376	3	1	12	69,948	20
8. İzmir	2,220,988	6	4	44	50,477	56
9. Bursa	1,202,264	3	0	12	100,188	30
10+11. İstanbul	5,300,454	13	5	63	84,118	133

Table 3. Required bed planning targets for regional centers.

Center	Region	PCC specialists	Level 3 PICU beds with a PCC specialist	Total level 3 PICU beds with a PCC specialist	Target bed number per population size
Erzurum Region	1	0	0	0	54
Diyarbakır Region	2	0	0	0	53
Gaziantep University Medical Faculty	3	1	8	8	64
Kahramanmaraş University Medical Faculty	3	1	0		
Adana - Çukurova University Medical Faculty	4	1	12	22	70
Kayseri - Erciyes University Medical Faculty	4	1	10		
Samsun Region	5	0	0	0	22
Ankara University Medical Faculty	6	1	6		
Gazi University Medical Faculty	6	1	4		
Hacettepe University Medical Faculty	6	1	8	35	95
Eskişehir Osmangazi University Medical Faculty	6	1	9		
Konya - Necmettin Erbakan University Medical Faculty	6	1	8		
Antalya - Akdeniz University Medical Faculty	7	1	6	6	20
İzmir - Behçet Uz Education and Research Hospital	8	1	10		
İzmir - Dokuz Eylül University Medical Faculty	8	1	6	34	56
İzmir - Ege University Medical Faculty	8	1	8		
İzmir - Tepecik Education and Research Hospital	8	1	10		
Bursa Region	9	0	0	0	30
İstanbul Bakırköy Education and Research Hospital	10+11	1	9		
İstanbul - Bezmî Alem Medical Faculty	10+11	1	10		
İstanbul Cerrahpaşa Medical Faculty	10+11	1	10	42	133
İstanbul Çapa Medical Faculty	10+11	1	6		
İstanbul Marmara University Medical Faculty	10+11	1	7		
Total		19	147	147	597

are working in the centers in Zonguldak, Mersin, Tokat, and Samsun, are instructors at their institutions. These 6 doctors may be employed in the regions where there is no PCC specialist. In this way the needs of the 5th and 1st regions may be met.

4.7.2. Second region

The pediatric population in this region is 2,122,951, the PICU bed/child ratio is 1/81,611, and there is no specialist in this region. The number of tertiary PICU beds already existing is 26 and the required number of PICU beds is 53. Two RECCCs should be constructed in this region and these should be placed in Diyarbakır and Elazığ (Table 3). Two of the first fellows who will graduate in 2014 must be employed in this region, and until that time the 2nd region must be supported by the 3rd and 4th regions.

4.7.3. Third region

There are 2 PCC specialists in this region. Sixty-four new PICU beds are needed for the pediatric population of 2,561,505. The 2 centers where the PCC specialists are working should be transformed to RECCCs (Table 3).

4.7.4. Fourth region

There are 2 PCC specialists in this region and a PICU instructor in Mersin. The bed requirement according to the pediatric population in this region is 70 beds. Three RECCCs in Adana, Kayseri, and Mersin will be enough for this region (Table 3).

4.7.5. Fifth region

There is no PCC specialist in this region but 4 doctors who are actively working in PICUs have become instructors at their institutes. The pediatric population size is relatively

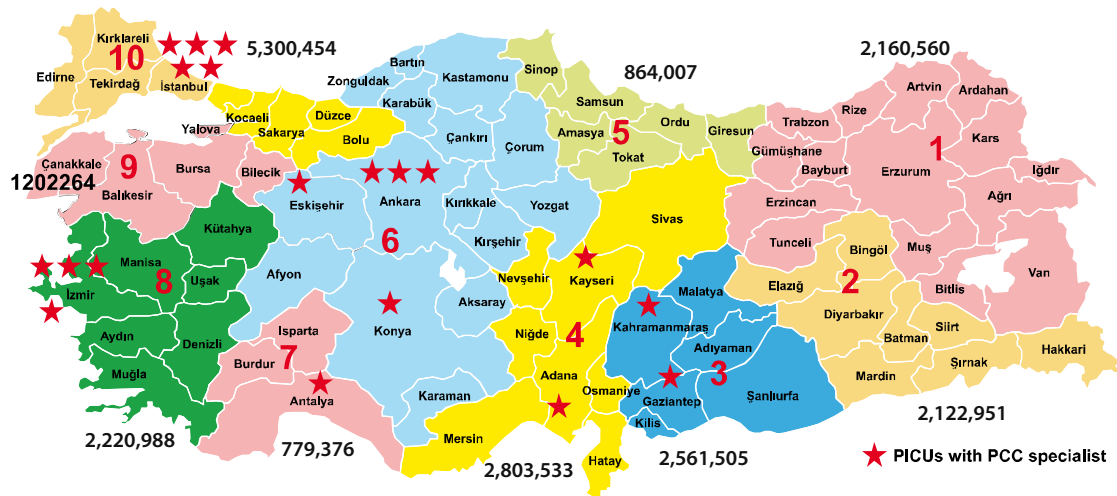


Figure 9. Health care regions and centers with a PICU specialist.

small and 1 RECCC will be enough for this region. This center should be placed in Samsun and 1 of the instructors still working in Samsun may be employed here (Table 3). The 3 other instructors must urgently be employed in the 1st, 2nd, and 9th regions where PCC specialists are needed.

4.7.6. Sixth region

There are 5 PCC specialists in this region. The number of beds needed for the pediatric population in this region is 90. In this region, 5 RECCCs should be constructed in the centers where the specialists are currently working. These centers must be placed in Ankara (3 of them), Konya, and Eskişehir (Table 3).

4.7.7. Seventh region

There is a PCC specialist in this region who is working in Antalya. Because of the relatively small size of the pediatric population the target PICU bed number is 20. The transformation of the center in Antalya to a RECCC will be enough for this region (Table 3).

4.7.8. Eighth region

In this region there are 4 PCC specialists: 2 of them in a Ministry of Health training and research hospital and 2 of them in university hospitals. The number of beds needed for the pediatric population in this region is 86. The 4 centers where these specialists are working should be transformed to RECCCs and every center should include 14 beds (Table 3).

4.7.9. Ninth region

There is no PCC specialist in this region. The number of beds needed for the pediatric population in this region is 30. Eighteen beds should be added to the existing 12 beds and a RECCC should be constructed in Bursa. Additionally, 1 of the fellows who will graduate in 1.5 years should be employed there and the personnel, beds, and equipment necessary for a RECCC should be prepared for that time (Table 3).

4.7.10. Tenth and 11th regions

When evaluated together as the İstanbul region, this region has the highest number of beds but also has the highest bed deficit according to the pediatric population of the regions. In this region, there are 5 PCC specialists and 1 of them is working in a Ministry of Health-affiliated hospital. The total number of beds needed for the pediatric population of 5,300,454 is 133. The centers where the specialists are working should be transformed to RECCCs and bed numbers in these should be 26 or 27 beds (Table 3).

In conclusion, this study summarized the current state of Turkey's PICUs. Despite the increase in PICU bed numbers compared to previous years, the current number of PICU beds is not enough to supply critical care services to the children in Turkey. The insufficient number of PCC specialists should have priority over the low number of PICU beds. The current number of PCC specialists is not enough to cover the current PICU beds. Another problem is the high percentage of inappropriate use of PICU beds, which was found to be due to inappropriate decisions while selecting patients for PICU admissions regarding patient diagnosis and characteristics, in addition to the problems in transfer and follow-up of critically ill patients. Our results showed that PICUs staffed with PCC specialists had a more efficient and higher quality of patient care (lower SMR). Having PCC specialists in PICUs was also found to be an important factor in preventing wasting of resources. The insufficient number of PICU nurses for the current PICU beds also indicates that this problem is going to be more prominent as new PICU beds are opened. Patients with terminal illnesses or patients requiring chronic home medical care who are admitted to PICUs are also adding to the current wasting of resources in PICUs.

It is important that an increase in specialists should be followed by an increase in beds. Otherwise, the deficit will

become more prominent, and this situation will cause the waste of resources. There should be a gradual increase in PCC specialist numbers. The first step must be meeting urgent needs, and then reaching the ideal number while replacing the PCC specialists who retire. An emergency action plan for meeting urgent needs must be created. In the emergency action plan, employment for certain centers and infrastructure studies should be present. The number of fellows who will graduate in 2014 is not enough to meet the urgent needs. RECCCs will also need more than 1 specialist.

In Turkey, 19 specialists are employed in centers where PICU fellows can be trained. As a first-year program of an emergency action plan, the maximum number of fellows must be accepted to the fellowship programs and the number of fellows must decrease gradually in subsequent years. For the first year, this number should not be below 30. It should also be considered that some of the programs would not be able to fill all of their positions. When 25 PCC fellows enter the fellowship programs, there will be 1 PCC fellow for each 5 PICU beds, and this ratio is acceptable for training quality. In this step, the rate limiting factor will be the inadequate number of applications for the opened fellowship positions because of the difficult working conditions in PICUs. For this reason, improvement in conditions, and especially in incomes of PICU personnel, must be planned, and in this way PCC fellowship programs may become more preferable. Yearly fellow numbers entering programs should be determined by evaluating patient numbers, bed numbers, instructor numbers, and the presence of other supporting subspecialties. Even if 25 fellows begin PCC education, reaching the target PCC specialist number will take 19 years. Because of this, some of the newly graduated PCC specialists must become instructors and begin to educate new PCC fellows.

The problem of occupation of limited number PICU beds by terminal or chronic medical care patients can be solved by generalizing and improving home care systems. In a similar manner, pediatric palliative care centers should be urgently constructed. In this way, PCC bed capacity will increase in cost-effectiveness. Pediatric palliative care centers must be planned via the 6 health service regions map, and centers must first be placed in Erzurum, Gaziantep, Adana, Ankara, İzmir, and İstanbul. Forty-two percent of existing PICU beds were occupied by chronic medical care patients and the total number of these patients was 240. In the first step, the number of beds that these palliative care centers have should be 20. In this way, only half of the need will be met. In the second step, the number of centers must be increased and distributed among the 11 health service regions.

It should be considered that the present deficit in PICU nurse number will be more prominent after increasing PICU beds. Not only an increase in the number of certification programs in nursing services but also an improvement in their quality should be initiated. The minimum necessary nurse number for PICUs that was determined by the government in February 2012 should be obligatory for all the centers.

When the RECCCs are constructed there will be no need for the terminology of 'secondary' or 'tertiary' PICUs. Every hospital can include its own PICU, which will function for stabilization of critical patients. Patients who need further management should be transferred to RECCCs. These regional services will be providing tertiary PCC services. After the regionalization process, PICU and RECCC terminology should be used instead of 'secondary' or 'tertiary' PICUs. Thus, problems regarding payment and hospitalization will be diminished. RECCCs should take patients from other centers by a 2-way transfer system. Turkey's 112 emergency help system's infrastructure is competent for 2-way transfers, but procedural studies should be started. When the RECCCs are constructed with emergency rooms, all emergency/critical patients may be directly transferred to these centers via 112 emergency services. However, due to the intense patient flow to these centers, the ideally functioning RECCC must be able to see all the available pediatric beds that are monitored by the 112 command system for patients who do not need PICU level medical care.

Additionally, a database to be used by all RECCCs must be established. A central command system is also necessary in order to follow occupancy of beds, turnover, and mortality scores of centers. Centrally controlled RECCCs create an advantage when meeting supply and medical equipment needs without any waste. Regional center construction is also an eligible solution model for training and certification of PICU personnel.

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