

# Long Stay and Frequent Readmission in the Pediatric Intensive Care in The Netherlands; 15-Year Time Trends

**OBJECTIVES:** To describe time trends and the burden of long-stay patients (LSP) and frequent-readmission patients (FRP) in the PICUs in The Netherlands.

**DESIGN:** Retrospective analysis of data from the nationwide Pediatric Intensive Care Evaluation registry including all PICU admissions in The Netherlands.

**SETTING:** All PICUs in The Netherlands.

**PATIENTS:** All PICU patients less than 18 years old admitted between 2003 and 2017. Two groups of patients were identified: LSP (admitted  $\geq 30$  d) and FRP ( $\geq 3$  readmissions within the first year after their first admission).

**INTERVENTIONS:** None.

**MEASUREMENTS AND MAIN RESULTS:** A total of 47,424 children were admitted on 59,759 occasions. LSP (3.3% of total cohort) and FRP (2.1%) accounted for 37.5% and 14.5% of cumulative admission days, respectively. Patients fulfilling both LSP and FRP criteria (0.6%) accounted for 9.9% of cumulative admission days. No significant time trends were observed between 2003 and 2017 for the number of LSP and FRP, nor for accounted cumulative admission days. Age and disease severity-adjusted mortality was significantly higher for LSP (odds ratio [OR], 2.16; 95% CI, 1.66–2.82;  $p < 0.001$ ) and FRP OR 1.40 (95% CI, 0.97–2.01;  $p = 0.069$ ) compared with the general PICU population. Overall PICU mortality decreased significantly between 2003 (6.5%) and 2017 (3.7%;  $p = 0.004$ ), but remained constant over time for both LSP (17.2%) and FRP (6.3%).

**CONCLUSIONS:** The proportion of LSP and FRP and their burden on PICU capacity are considerable and remained constant between 2003 and 2017. Whereas age and disease severity-adjusted mortality decreased in the general PICU population, it did not change in LSP and FRP.

**KEY WORDS:** bed occupancy; length of stay; pediatric intensive care unit mortality; pediatric intensive care unit readmissions; pediatric intensive care unit

Advances in medical knowledge have transformed many pediatric diseases previously associated with poor prognosis into chronic and often complex conditions (1). Patients suffering from these diseases are prone to prolonged and frequent admissions to the PICU (2). This has changed characteristics, course of disease, and outcome of the PICU population (1, 3, 4). Although small in number, the respective share of total bed-occupancy days and healthcare costs incurred by long-stay PICU patients is extensive (5–8) and continues to rise in parts of the world, representing a serious and increasing burden on PICU capacity (5, 6, 8). However, information about nationwide trends in The Netherlands is lacking. The aim of this study is, therefore, to describe time trends, PICU mortality rates, and the burden of long-stay admissions and frequent readmissions to the PICUs in The Netherlands between 2003 and 2018.

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## KEY POINTS

**Question:** The purpose of this study is to describe time trends and the burden of patients with lengthy and frequent PICU admissions in The Netherlands over the course of 15 years.

**Findings:** This retrospective data analysis shows that between 2003 and 2017, a minor proportion of the total Dutch PICU population (4.8%; patients with lengthy and frequent admissions) comprised over 40% of total cumulative admission days.

**Meaning:** To cope with this burden in the future, better facilities are needed to care for these groups of care-intensive patients and to continue to provide PICU resources judiciously.

## MATERIALS AND METHODS

Patients were identified through the national Pediatric Intensive Care Evaluation (PICE) registry, in which data of all PICU admissions in The Netherlands are prospectively recorded. During the period under study, there were eight PICUs in The Netherlands (see **Supplementary Files**, <http://links.lww.com/CCX/B92>, for additional information about all PICUs). We screened all admission records between 2003 and 2018. Anonymized patient unique identification codes were provided to identify unique patients. Per unique patient, the first recorded PICU admission between January 1, 2003, and December 31, 2017, and any readmission within 1 year after the first admission until December 31, 2018, were included. To ensure an equal comparison over the years, inclusion of readmissions was limited to a 1-year follow-up period per patient after the first admission. PICU admission day was defined as any calendar day of a PICU admission. Long-stay patients (LSP) were defined as patients with at least one PICU admission of 30 consecutive days or more. Patients with three or more PICU admissions (regardless of duration—both planned and unplanned) within the 1-year follow-up were defined as frequent readmission patients (FRP). Cumulative admission days were defined as the sum of PICU admission days, both from the first PICU admission and all PICU readmissions within the 1-year follow-up.

Age, sex, month and year of PICU admission, admission indication (results published in **eTable 1**, <http://links.lww.com/CCX/B92>), complex chronic condition (CCC, as defined by Feudtner et al [9]), planned or unplanned PICU admission, length of stay of first PICU admission, month and year of PICU discharge, Pediatric Index of Mortality (PIM) 2 scores, and PICU mortality were extracted. PICU mortality was registered when death occurred during PICU admission, and, if PICU readmission occurred, was limited to death during PICU readmission within a 1-year follow-up period.

The study protocol W21\_436#21.485 was approved on October 21, 2021, by the Medical Ethics Review Committee of the Academic Medical Center in Amsterdam, which confirmed that the Medical Research Involving Human Subjects Act did not apply, and the study was, therefore, compliant with the 1975 Declaration of Helsinki.

Statistical analyses were performed using IBM Statistical Product and Service Solutions (SPSS) Statistics (Version 28.0 for Windows; SPSS, Chicago, IL). For all analyses, LSP and FRP groups were compared with patients not fulfilling LSP and/or FRP criteria (considered as the general PICU population). Categorical data and proportions were expressed as number and/or percentages and tested for significance using chi-square test. Continuous data were expressed as median (interquartile range [IQR]), and Kruskal-Wallis was used to test for significance. For time trend analysis of proportions, the Jonckheere-Terpstra test, assuming there is a natural a priori ordering, was used. Logistic regression analyses were performed to analyze age and PIM2-adjusted PICU mortality odds ratios (ORs) between groups. *p* value of less than 0.05 was considered significant.

## RESULTS

Between January 1, 2003, and December 31, 2017, a total of 47,424 patients were admitted to one of the eight Dutch PICUs. Up to December 31, 2018, these patients were admitted on 59,759 occasions and accounted for 348,437 cumulative admission days. The overall PICU mortality rate was 4.4%.

### Long-Stay Patients and Frequent-Readmission Patients

Total numbers, cumulative admission days, and PICU mortality of general PICU population, LSP,

**TABLE 1.**  
**Characteristics of General PICU Population Compared to Long-Stay and/or Frequent-Readmission Patients**

Patient Characteristics	General PICU Population <sup>a</sup>	LSP	FRP	Patients Fulfilling Both LSP and FRP Criteria
Number of patients (%)	45,144 (95.2)	1,578 (3.3)	993 (2.1)	291 (0.6)
Number of female (%)	19,470 (43.1)	681 (43.2)	422 (42.5)	135 (46.4)
Age at first PICU admission, mo (IQR)	24 (3–106)	2 (0–22) <sup>b</sup>	3 (0–34) <sup>b</sup>	1 (0–6) <sup>b</sup>
Length of stay first PICU admission, d (IQR)	2 (1–5)	40 (30–64) <sup>b</sup>	6 (2–18) <sup>b</sup>	29 (7–60) <sup>b</sup>
Planned first PICU admission (%)	18,488 (41.0)	465 (29.5) <sup>b</sup>	413 (41.6)	105 (36.1)
Complex Chronic Condition (%)	11,435 (25.3)	981 (62.6) <sup>b</sup>	687 (69.2) <sup>b</sup>	219 (75.3) <sup>b</sup>
Pediatric Index of Mortality (PIM) 2-score at first PICU admission (% median [IQR])	1.2 (0.6–3.2)	2.8 (1.1–7.6) <sup>b</sup>	1.3 (0.6–3.4)	1.7 (0.8–4.4) <sup>b</sup>
PICU mortality (%)	1,797 (4.0)	272 (17.2) <sup>b</sup>	63 (6.3) <sup>c</sup>	28 (9.6) <sup>b</sup>
Cumulative admission days (%)	201,738 (57.9)	130,568 (37.5)	50,569 (14.5)	34,438 (9.9)

FRP = frequent-readmission patients, IQR = interquartile range, LSP = long-stay patients.

<sup>a</sup>General PICU population (defined as PICU patients not fulfilling LSP or FRP criteria).

<sup>b</sup> $p < 0.001$  (compared with general PICU population).

<sup>c</sup> $p < 0.05$  (compared with general PICU population).

FRP, and patients fulfilling both LSP and FRP criteria are shown in Table 1 and **eFigure 1** (<http://links.lww.com/CCX/B92>). Patients fulfilling either LSP or FRP criteria (2,280 patients, 4.8%) accounted for 146,699 cumulative admission days (42.1%) and were significantly younger and more frequently diagnosed with CCC. PIM2-probability of mortality was significantly higher in LSP and patients fulfilling both FRP and LSP criteria compared with the general PICU population. The age and PIM2-adjusted PICU mortality OR were 2.16 (95% CI, 1.66–2.82) for LSP and 2.37 (95% CI, 1.55–3.62) for patients fulfilling both criteria compared with the general PICU population ( $p < 0.001$ ). For FRP, this OR was 1.40 (95% CI, 0.97–2.01;  $p = 0.069$ ).

### Time Trends

No time trends were observed in proportion of LSP and/or FRP and their share of cumulative admissions days (**Fig. 1, A and B**). Overall age and PIM2-adjusted PICU mortality rate decreased significantly from 6.5% in 2003 to 3.7% in 2017 ( $p = 0.004$ ). For LSP and/or FRP, no significant decrease in age and PIM2-adjusted PICU mortality OR was observed.

### WHAT IS KNOWN?

- PICU demand is increasing with an increase in chronically ill patients, who often account for high use of PICU resources.
- Globally, PICU mortality has decreased significantly, but long-stay PICU patients continue to have relatively high mortality rates.
- Several studies show that long PICU stay is associated with poor prognosis, disproportionate use of hospital resources, and lower quality of life.
- In order to be able to keep providing ICU care to all admitted patients, intermediate care facilities and interventions focused on chronic complex care should be explored.

### DISCUSSION

Our results showed that LSP and FRP, even though small in number, comprised over 40% of cumulative PICU admission days, which remained constant over time. Overall PICU mortality decreased significantly

### WHAT DOES THIS STUDY ADD?

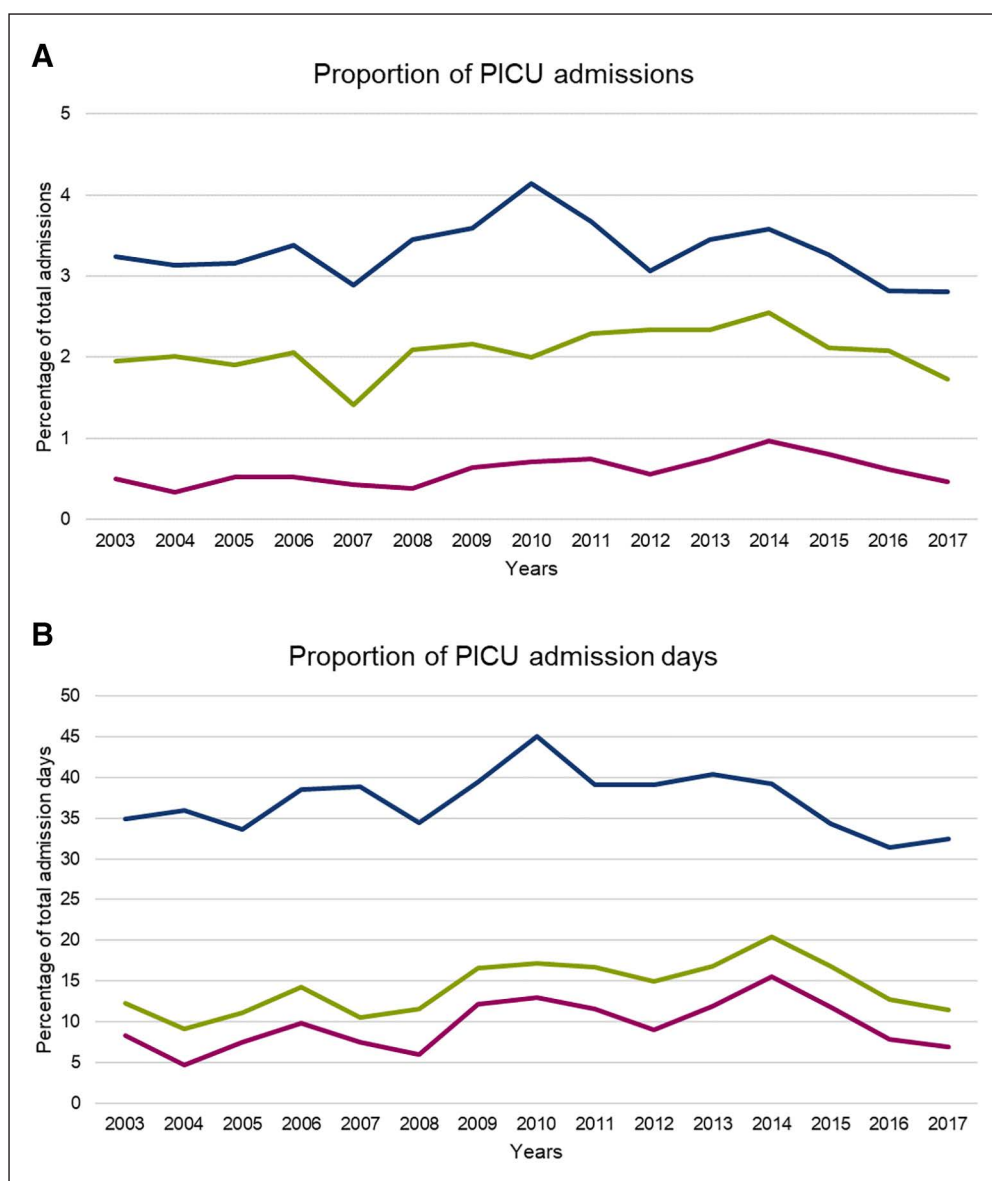
- First analysis of nationwide longitudinal data about the total PICU population.
- Focus on both long-stay PICU patients as well as patients with frequent readmissions as a measure of PICU resource use.
- Comparison to numbers and trends reported in similar studies in other parts of the world.

during the study period; however, this trend was not observed among LSP and/or FRP, who continued to have much higher PICU mortality rates compared with the general PICU population. Our results are consistent with other studies showing that small numbers of LSP (2–8% of the PICU population) account for up to 60% of admission days (5, 6, 8). Several studies reported unfavorable outcomes associated with LSP, including high mortality rates, new moderate-to-severe disabilities, poorer reported quality of life, and chronic technology dependence (4, 5). Our results confirm that

CCC are more frequently represented among LSP. This was also the case for FRP, a group that has not been studied separate of LSP. Though only 2.1% of all PICU admissions, FRP surprisingly accounted for 14.5% of cumulative admission days. Thus, both LSP and FRP continue to take up a substantial part of scarce PICU resources in The Netherlands.

LSP and FRP numbers and their burden on PICU capacity remained constant between 2003 and 2017, which contradicts a sustained increase reported in other studies (5–7). We can only speculate about the reason for these contrasting results. Increased availability of medical technical support at home and a greater number of transitional and palliative care units may have resulted in shorter and less frequent PICU admissions of these patients mainly representing CCC.

Consistent with other studies, both disease severity (according to PIM/Pediatric Risk of Mortality



**Figure 1.** Time trends for long-stay and/or frequent readmission patients between 2003 and 2017. **A**, Proportion of PICU admissions per subgroup. **B**, Proportion of cumulative admission days per subgroup.



[PRISM] scores) at admission and PICU mortality are significantly higher for LSP compared with the general PICU population (7, 10). Previous studies did not adjust mortality for PIM/PRISM-scores, and we are the first to show that age and PIM2-adjusted PICU mortality remain higher for LSP and FRP patients. During the study period, overall PICU mortality decreased significantly, whereas, unlike other European studies, this was not observed within our LSP and FRP subgroups (6, 8). However, cross-study and cross-cultural comparisons are hampered by different views on PICU admission indications and reasons for discharge including end-of-life decisions.

A key strength of this study is the standardized registration of PICU admissions in The Netherlands, which allowed the analysis of long-term nationwide trends in a large number of admissions. To minimize potential bias, we ensured an equal 1-year follow-up period for all included patients. However, this still may have over- or underestimated utilization of the studied admissions, particularly in the first year of the study in which every unique patient was included as a first admission.

## CONCLUSIONS

Although small in number compared with the general PICU population, both LSP and FRP comprise over 40% of total cumulative admission days. Between 2003 and 2017, overall PICU mortality decreased significantly, but PICU mortality rates of LSP and FRP did not decline and remained significantly higher compared with the general PICU population. The consistently high use of PICU resources by LSP and/or FRP remains a great concern. New care facilities such as transitional care units can potentially ease the burden on PICUs worldwide.

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