Inpatient and Outpatient Health Care Utilization of Children and Adolescents with Type 1 Diabetes before and after Introduction of DRGs

C. Bächle¹, B. Haaster², R. W. Holi³, P. Beyer¹, M. Grabert¹, G. Giani¹, A. Icks¹,² for the DPV initiative

Abstract

Objective: To analyze the frequency and length of hospital stays as well as the frequency of diabetes-associated outpatient visits of children and adolescents with type 1 diabetes before and after the introduction of DRGs (diagnosis-related groups) in German hospitals.

Methods: For this prospective cohort study, data from 2000 (before introduction of DRGs) to 2008 (after introduction) was extracted from the German diabetes documentation software DPV. Incidence rates of hospitalizations, length of hospital stays as well as the incidence rates of outpatient visits of 21,502 children and adolescents were estimated. The associations between the target parameters and DRG introduction, age, sex, diabetes duration, calendar year and migration background were estimated using generalized linear mixed models.

Results: Incidence of hospitalization was 0.45 (95% CI: 0.44–0.45) per person-year (PY), mean number of hospital days 2.77/PY (95% CI: 2.76–2.79). Children had 5.3 (95% CI: 5.3–5.3) outpatient visits per PY on average. The number of hospital stays, inpatient days, and outpatient visits decreased significantly between 2000 and 2008. Time of introduction of DRGs was related to a significant rise in the number of hospital stays and outpatient visits (p<0.05). There was no significant relation to the number of hospital days. Compared with children younger than eleven years of age, 11- to 14-year-old children had significantly more, adolescents older than 14 years significantly less hospital stays (RR 1.2, 95% CI: 1.14–1.23 and 0.92, 95% CI: 0.87–0.97, respectively). Migration background was significantly associated with worse results for all analyzed target variables (RR 1.21 for hospital stays, 1.26 for hospital days, 1.07 number of outpatient visits).

Conclusions: The introduction of DRGs in the care of patients with pediatric diabetes mellitus resulted in a leveling of the reduction of the number of outpatient visits and hospital stays. Especially adolescents at the age of puberty and patients from families with migration background seem to require particular attention in health care.

Introduction

Type 1 diabetes mellitus is not only the most frequent chronic metabolic disease in childhood and adolescence, but the incidence has also increased all over the world (The DIAMOND Project Group, 2006). With respect to the comparatively long live expectancy, optimal care of this patient group is of great social importance. Particularly the sustained provision of specialized, comprehensive support seems to pose a big challenge (Icks et al., 2001a). In Germany, diagnosis-related groups (DRGs) have been implemented between 2003 and 2005. DRGs are intended to result in more efficiency in inpatient care combined with raised transparency of both costs and services and improved quality of treatment (Böcking et al., 2005, SVR, 2007). Thus, changes of services in the inpatient as well as the outpatient sector can be expected as a consequence of DRGs. Knowledge about possible changes in pediatric diabetes care are lacking.

The aims of the present study were to evaluate changes of main health care processes during 2000–2008, a period which includes the introduction of DRGs among children and adolescents with type 1 diabetes mellitus. In addition, changes in the frequency of diabetes-associated outpatient visits were estimated.
Patients and Methods

Study design and data basis
The present study is a prospective cohort study based on data from the German diabetes documentation software DPV. In this computer program, information of children and adolescents with diabetes (especially type 1 diabetes mellitus) is documented, anonymized and collected centrally. At present, DPV covers approximately 200 German pediatric diabetes units (hospitals and general practices) which corresponds to 90% of all units with a main focus on pediatric diabetes. About 85% of all affected pediatric patients in Germany are treated in the participating facilities. Before each evaluation data are checked for integrity, i.e. documentation sheets of patients that are possibly wrong are retransferred to the clinics for verification (Holl, 1998). The DPV program has been widely used for scientific analyses (Dost et al., 2008, Gerstl et al., 2008, Jakisch et al., 2008, Herbst et al., 2007, Icks et al., 2007, Ralle et al., 2007, Icks et al., 2004a, Icks et al., 2001b, Icks et al., 2001c).

For the present analysis, data starting in 2000, i.e. before the introduction of DRGs, until September of 2008 was included. For this period, information of 32 997 patients from 173 clinics was available. Rehabilitation clinics were excluded from the study. The fact that time of introduction and effects to the budget varied from clinic to clinic was taken into account for the analysis: Clinics received detailed information about the aims and methods of the study and were asked to report the time of introduction of DRGs by a standardized questionnaire.

Study population
Altogether 130 clinics (75%) answered the question for the time of DRG introduction. In the 130 facilities, 24 359 patients with pediatric type 1 diabetes were treated. For the current analysis, only patients who attended clinics for more than three months during the study period were included. Therefore, 2 857 were excluded, leaving 21 502 children and adolescents with pediatric diabetes who were included in the main analyses (Table 1). Ninety clinics (69%) introduced DRGs in 2003, thirty-one (30%) in 2004 and one in 2005.

Target parameters and associated factors
Target parameters were the incidence rates of hospitalizations, mean length of hospital stays as well as the incidence rates of outpatient visits. Furthermore, age (age groups <11, 11–15, 15 years and older), sex, diabetes duration (categories <2, 2–5, 5–10, 10 years and longer), calendar year (discrete, ordinal), and social status, were investigated with respect to factors possibly associated with the target parameters. Social status was operationalized by a proxy for migration background (German vs. non-German).

Statistical analysis
First, descriptive statistics were performed for all continuous and categorical variables. According to their distribution variables were presented by frequency distributions, means with standard deviations and ranges. Crude incidences (person-years) were estimated with 95% confidence intervals (CI) assuming Poisson distribution for the number of particular events considered.

For outpatient visits, individual incidence rates (number of contacts per person-year) were calculated. Target variables were documented in repeated time intervals per patient. In principle, repeated visits of the patients should occur quarterly, but there were gaps in the time schedule. Events and observation times were documented retrospectively in each interval per patient. To account for the influence of covariates on each target variable generalized linear mixed models (GLMM) were fitted. Dependencies of the repeated measurements per patient and variations between the centers were modeled by random effects, whereas the covariates pre/post introduction of DRGs, ordinal calendar year (since 2000), migration background (yes/no), age (3 categories: <11, 11–15, 15 years and older), diabetes duration (4 categories: <2, 2–5, 5–10, 10 years and longer), and sex were regarded as fixed effects. In addition, potential interactions between calendar year (since 2000) and the primary influence factor pre/post DRG-introduction were estimated corresponding to the question if the association between outcome and change to DRGs is constant over the years or varies between calendar years for example because of differences in therapy regimes (introduction of insulin analogues, increasing use of CSII). This question was primarily relevant for the years in those data from before as well as after introduction of DRGs was available (DRG: 2003–2005).

For consideration of overdispersion all analyses were dscale-adjusted. All analyses were performed using the Statistical Analysis System SAS (SAS for Windows, Release 9.2 (TS1M0), SAS Institute Inc., Cary, NC, USA).

Results

Study population
The characteristics of the 21 502 children and adolescents of the study population are described in Table 1. There were no relevant differences in terms of age, sex, and diabetes duration between patients of the 130 clinics with and 41 clinics without information on the time of introduction of DRGs (in the latter, 6 068 patients were cared for). In centers with such information the 2 857 children and adolescents who were excluded due to observation periods less than three months were compared with all children and adolescents included in the analysis: The children included were significantly younger (mean age at beginning of observation period or beginning of documentation in DPV: 10.1 vs. 11.6 years), and diabetes duration was shorter than in patients who were excluded.

Table 1 Description of the study population, DPV prospective documentation, Germany, 2000–2008.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>21 502</td>
</tr>
<tr>
<td>sex [% male]</td>
<td>52</td>
</tr>
<tr>
<td>age at study onset [years]; mean ± SD (range)</td>
<td>10.1 ± 4.2 (0–18)</td>
</tr>
<tr>
<td>diabetes duration [years]; mean ± SD (range)</td>
<td>2.0 ± 3.1 (0–16.5)</td>
</tr>
<tr>
<td>migration background [%]</td>
<td>6.1</td>
</tr>
<tr>
<td>person-years covered</td>
<td>68 672</td>
</tr>
<tr>
<td>before DRG-introduction</td>
<td>42 697</td>
</tr>
<tr>
<td>after DRG-introduction</td>
<td>25 975</td>
</tr>
<tr>
<td>incidence of hospitalization (CI*)</td>
<td>0.44 (0.44–0.45)</td>
</tr>
<tr>
<td>hospital stay per admission [days]; mean (SD)</td>
<td>6.1 (4.1)</td>
</tr>
<tr>
<td>no of hospital days per person year; mean (CI*)</td>
<td>2.77 (2.76–2.79)</td>
</tr>
<tr>
<td>no of outpatient visits per person year; mean (CI*)</td>
<td>5.3 (5.3–5.3)</td>
</tr>
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* 95% confidence interval
During the observation period, 56% of patients were hospitalized at least once, 32% had more than one admission. Mean hospital stay per admission was 6.1 days (SD 4.1). Incidence of hospitalization was 0.45 (95% CI: 0.44–0.45) per person-year and the number of hospital days per person-year was 2.77 (95% CI: 2.76–2.79). The most common reason for hospital stays and hospitalization was 0.45 (95% CI: 0.44–0.45) per person-year.

Description of processes of care during 2000 and 2008

The number of hospital stays, the number of hospital days as well as outpatient visits between 2000 and the middle of 2008 decreases slightly. There seems to be a steeper decrease at the beginning of the observation period, and a leveling off after 2002. The trend of hospital admissions, hospital days, and ambulatory contacts per year 2000–2008 is shown for each year in Fig. 1.

Considering the results before and after the introduction of DRGs in the years 2003 and 2004 (2005 not described, since only one clinic introduced DRGs in this year), there seem to be no obvious differences in hospital stays (pre/post 2003: 0.45 vs. 0.43 per PY, 2004: 0.41 vs. 0.44 per PY). The number of hospital days decreases slightly (2003: 2.92 vs. 2.6 days, 2004: 2.83 vs. 2.71 days), ambulant contacts, in contrast, increase (2003: 5.11 vs. 5.58 per PY, 2004: 4.82 vs. 5.29 per PY).

Processes and association with DRG introduction: Results from regression analyses

Fig. 2 shows the results of the regression analyses. The presented models include migration status and calendar year (ordinal trend variable). For clarity purposes and better interpretation, interaction terms are not illustrated, yet, interaction was included in additional models, and results are described below. Considering process indicators combined with annual trend and introduction of DRGs, adjusted for age, sex, diabetes duration, and migration background, small, albeit partly significant, associations can be seen. The number of hospital stays and inpatient days decreased significantly between 2000 and 2008 (annual trend). Time of introduction of DRGs was related to a significant increase in the number of hospital stays; there was no significant
relation between DRG-introduction and the number of hospital days. Also outpatient visits decreased significantly between 2002 and 2008. The introduction of DRGs was associated with a significant increase of outpatient visits.

The estimation of interactions between annual trend and introduction of DRGs is based primarily on data in 2003 and 2004, when centers with and without DRGs were observed simultaneously. For the number of hospital stays and outpatient visits, we found significant interactions between annual trend and introduction of DRGs (p < 0.05): after the introduction of DRGs, the reduction of hospital stays became slower (p < 0.05). Similarly, there were significant interactions between annual trend and implementation of DRGs (p < 0.05): after the introduction of DRGs, the decrease of outpatient visits was leveled off (p < 0.05).

Relative risks and age, sex, diabetes duration, migration background
For all process indicators, the relative risks comparing categories of the predictors sex, age, diabetes duration as well as migration background, adjusted for annual trend and migration background, might be more important than those concerning DRG-introduction (see Fig. 2).

Among boys, hospitalization and the number of outpatient visits (RR 0.89 and 0.98; p < 0.05) were significantly lower than among girls. Compared with children younger than eleven years of age, 11- to 14-year-olds showed significantly more, adolescents older than 14 years significantly less hospital stays (RR 1.2 and 0.92, respectively). Last-mentioned also had marginally, but significant less outpatient visits. Children and adolescents who had diabetes for more than two years had significantly more outpatient visits, the number of hospital stays, in contrast, did not change significantly. Migration background was significantly associated with worse results for all analyzed target variables. On average, children and adolescents from families with migration background were about 20% more often in hospital, their hospital stays lasted about 25% longer. Outpatient visits were also significantly more frequent; however, the relative risk was lower compared to hospital stays and durations (RR 1.07).

Discussion

General findings
The aim of the present study was to analyze care delivery processes in pediatric diabetes mellitus between 2000 and 2008, a period which includes the introduction of DRGs in Germany. Results indicate only small changes of the target variables after introduction of DRGs. After the introduction of DRGs, a relative increase or a leveling off of the earlier decrease in inpatient admissions and outpatient visits could be observed.

However, as also shown in earlier studies (Icks et al., 2007, Icks et al., 2004b, Icks et al., 2003, Icks et al., 2001a), there had been remarkable associations between process indicators and age, sex, diabetes duration, and migration background. Especially children and adolescents between 10 and 14 years, i.e. at the age of puberty, as well as those from families with migration background, had higher risks for hospitalization.

Explanation of the findings
The results of the associations between the target variables and the introduction of DRGs should be interpreted carefully considering the following aspects: (1) The existence of further factors that exert influence on the association between DRG-introduction and the target parameters like changes in the management of pediatric diabetes (increased use of CSII and insulin analogues, introduction of continuous glucose monitoring systems) can be assumed, even though relevant confounders are included and adjustment for calendar year was done. Other effects like patient selection cannot be excluded. (2) It must be taken into account that the study is similar to a before and after comparison after adjusting for relevant factors including annual trends. It is not possible to draw conclusions on the causality of associations from this study. Yet, the observed associations can be a starting point for specific discussions. (3) Strong dependencies between the included influencing factors (e.g. calendar year and DRG-introduction, apparent from significant interaction terms) might result in overall effects that cannot be separated clearly.

Furthermore, when interpreting the high relative risks it should be considered, that the first two years after onset of diabetes (reference group) require more frequent contacts for disease management than the subsequent years. Other aspects to consider are also special features of pediatric-diabetologic care. In Germany, care for children and adolescents with type 1 diabetes mellitus mainly takes place in specialized hospitals and their outpatient departments. Reimbursement modalities, in particular of ambulant care, are exceptionally heterogeneous; they range from no payment for ambulant care (performance exclusively by staff for inpatient care) to institutionalization of the ambulances with fixed per capita fees. Therefore, it can be assumed that the introduction of DRGs in treatment facilities resulted in changes of the financial conditions to varying degrees.

Evaluation of DRGs
Despite the legal obligation to evaluate DRGs, up to now valid results are lacking (SVR, 2007). Examinations on the effects of DRGs primarily address the adequacy of DRG-reimbursement, financial effects on clinics and aspects of coding of diagnoses as well as appropriateness of consideration of defined patient groups. For pediatric patients, insufficient reimbursement of the effort by means of fixed DRG-charges has often been discussed (Herrmann et al., 2008). With respect to the reduction of average duration of stay and the improvement of efficiency, the expert council states an improvement (SVR, 2007), but there are also opposite findings. For instance, the development of the number of cases and duration of stays was analyzed by the Gmünder Ersatzkasse (GEK) (Braun and Müller, 2006). There was no evidence for changes due to introduction of DRGs that exceeded the existing trend in inpatient care (rise in the number of cases, reduction of mean length of stay). Within the GEK-study, patients were asked for a subjective assessment of their hospital stays. And again, there was no indication for changes after introduction of DRGs. In view of missing evidence, the question, how DRGs affect quality of services and health outcomes, remains open (SVR, 2007).

Discussion of methods
Generally, an evaluation in terms of the examination of specific effects of DRGs is problematic, because randomized, controlled studies are not possible in this area. Non-randomized, controlled studies, and before-after-comparisons as used in the present project do not allow statements about the causality of associations. For the present study, data of a large population of pediat-
ric patients with diabetes was analyzed and observed for a long period. In the light of the complex dependency structures, there are still substantial methodical discussions. Therefore, the results should be interpreted carefully as discussed above. The strength of the study is that it used data of routine care, i.e. without sample bias, and furthermore, that the analyzed collective comprises a large proportion of all affected children and adolescents in Germany.

Conclusion

In conclusion, the introduction of DRGs in the care of patients with pediatric diabetes mellitus resulted in a leveling of the reduction of the number of outpatient visits and hospital stays in the first study period after 2000; however, the effects were low. The associations between the number of hospital stays, the length of hospital stays or the number of outpatient visits and the factors sex, age, diabetes duration as well as migration background seem to be considerably higher than those with DRG-introduction. Especially adolescents at the age of puberty and patients from families with migration background seem to require particular attention in health care.

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Conflict of interest: All authors declare that they have no conflict of interest.

Affiliations
1 Institute of Biometrics and Epidemiology, German Diabetes Center, Leibniz Center for Diabetes Research at Heinrich Heine University Düsseldorf, Germany
2 medStatistica, Neuenrade, Germany
3 Department of Epidemiology, University of Ulm, Germany
4 Clinic for Pediatrics, Protestant Hospital, Oberhausen, Germany
5 Institute of Medical Sociology, Department of Public Health, Heinrich-Heine University Düsseldorf, Germany

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