

Drug-Handling Problems and Expectations of the Ideal Pediatric Drug – Reported by Children and Their Parents

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Research Article

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Abstract

Experienced drug-handling problems and inadequately considered expectations for drug therapy have an unfavorable influence on therapy. We performed a questionnaire survey in (i) parents of 0–5-year-old children and (ii) 6–17-year-olds and their parents. We assessed (A) experienced drug-handling problems and (B) expectations for drug therapy. (i) 46 parents and (ii) 103 children and their parents participated in the study. Experienced drug-handling problems were described by (i) 100% of parents and (ii) 62% of children and 70% of parents. Problems concerned the preparation of the drug, dosing, compliance with the time interval, and acceptance. (i) 65% of parents preferred a peroral route of drug administration, while (ii) 74% of children and 86% of parents did so. Preferred characteristics of peroral drug formulations, e.g. liquid versus solid drug formulations or flavor, were highly heterogeneous. Preferences of 6–17-year-old children and their parents matched in 43% to 66%.

Conclusion: Most children and their parents had already experienced drug-handling problems. Preferences concerning the ideal pediatric drug were highly heterogeneous and in about half of cases, preferences of children and their parents differed. Thus, the children should be approached directly. If information is solely gained from parents, the children's needs might remain unmet.

What Is Known

- Pediatric drug administration is complex and therefore error-prone.
- Experiences and expectations of children and their parents should be considered.

What is new

- Most pediatric patients and their parents have already experienced drug-handling problems.
- Expectations concerning the ideal pediatric drug are highly heterogeneous. Parents are often insufficiently aware of those expectations in their children.

Introduction

Drug-handling problems are all problems that occur during storage, preparation for use, and actual drug intake. Those problems are common in children and adolescents [15, 16, 19]. So far, however, only a small number of studies addressed the perspective of children and their parents on drug-handling problems. For instance, in a questionnaire survey performed in 2015 among children in five European countries, bad taste of medicines, pain during administration, and difficulties in remembering to take drugs were the most commonly reported problems that may prevent appropriate drug use [13]. Regulatory authorities recognized this issue and addressed the challenges of drug use specifically in children. As an example, the Pediatric Regulation No 1901/2006, entered into force in Europe in 2007, aims at the development of drugs more suitable for use in children [14]. Despite these efforts, however, children's and parents' experiences and expectations of an ideal pediatric drug formulation have not yet been

sufficiently incorporated into these processes. A major reason for this is that there are hardly any systematic studies from the perspective of parents and children on this topic. For this reason, we performed a questionnaire survey of children and parents addressing (A) their own experiences in pediatric drug administration, and (B) their expectations of an ideal pediatric drug.

Materials And Methods

Setting and patients

After approval from the local ethics committee, we performed this prospective observational study at a German university hospital for children and adolescents from May 2019 to July 2020. We consecutively invited (i) parents of in- and out-patients aged 0 to 5 years and (ii) patients aged 6 to 17 years and their parents to take part in the questionnaire survey. During an in-patient stay or an appointment at the out-patient department, we approached patients and parents/caregivers who were legal guardians of the children. Requirements to participate in the study were in- or out-patient treatment, sufficient knowledge of the German language, and intellectual capacity to understand and answer the questions. Participation in this study was voluntary and without any compensation. Informed consent was gained from all participants. For the children's participation, parents/legal guardians as well as children gave their consent.

Data assessment

An expert panel consisting of pharmacists, a neuropsychiatrist, and a child and adolescent psychotherapist developed a questionnaire. To increase comprehensibility, the questionnaire contained photos and pictograms of drug formulations. The questionnaire was pretested with children and parents for comprehensibility and the questions were adjusted accordingly. During data collection, the same pharmacist was always present and read out questions, noted answers, or helped with comprehension problems as needed. This ensured a highly standardized data collection process for all participants. The following key issues were addressed in the questionnaire from the perspective of children and parents:

(A) Experiences of drug-handling problems

(B) Expectations of the ideal pediatric drug

(B.1) Favored route of drug administration

(B.2) Favored characteristics of peroral drugs

(B.3) Comparison of children's and parents' preferences concerning route of drug administration and favored characteristics of peroral drugs

(B.4) Description of the ideal pediatric drug in their own words.

The questions in the questionnaire had mainly pre-set answers to tick. Multiple answers were not intended, but if participants did not feel able to choose only one answer, all chosen answers were considered for the evaluation. To get a deeper insight into the participants' experiences and expectations, most questions were followed by an open question in which the participants were asked to explain why they chose the given answer.

Statistics

Statistical analysis was conducted by using Microsoft Excel 2019 (Version 16.0, Microsoft Corporation, Redmond, Washington, USA) and SPSS (Version 21, IBM Corporation, Armonk, New York, USA). Frequencies are reported in absolute and relative numbers. Continuous data were described as median with first (25%) and third (75%) quartile (Q25/Q75) and minimum/maximum (min/max). For comparisons, we performed Kruskal-Wallis tests and Mann-Whitney-U tests as appropriate. For these statistical tests, we excluded the data of those participants who gave multiple answers to single choice questions. An adjusted p-value ≤ 0.05 was considered to indicate significance.

Results

Patient characteristics

We interviewed (i) 46 parents of children aged 0–5 years and (ii) 103 pediatric patients aged 6–17 years and their parents. (i) The children aged 0–5 years were in median 2 years old (Q25/Q75: 1/3; min./max.: 0/5); 13 (28%) were female. The parents of the children aged 0–5 years had a median age of 33 years (30/37; 20/44); 37 (80%) were female. (ii) The children aged 6–17 years were in median 12 (9/15; 6/17) years old; 48 (47%) were female. The parents of the children aged 6–17 years had a median age of 41 (37/45; 25/63) years; 89 (86%) were female. The children's diagnoses comprised a wide spectrum of disorders, among others epilepsy, headache/migraine, diabetes mellitus type 1, acute and chronic respiratory disorders, gastroenteritis, and urinary tract infections. Of the children aged 0–5 years, 46% were on long-term medication, of the children aged 6–17 years 68%. For details on the participants' long-term medications, see Table 1.

Experiences of drug-handling problems (Part A)

Experiencing drug-handling problems during drug administration was reported by 46 (100%) of parents of 46 children aged 0–5 years, 64 (62%) of 103 children aged 6–17 years, and 72 (70%) of their parents. The described drug-handling problems concerned preparation of the drug, accuracy of dosing, compliance with the time interval, and acceptance of the child as displayed in detail in Tables 2 and 3.

Expectations of the ideal pediatric drug (Part B)

(B.1) Favored route of drug administration

Of the 46 parents of children aged 0–5 years, 30 (65%) favored a peroral route of drug administration for long-term medication, 8 (17%) preferred the rectal route, 5 (11%) a (trans-) dermal route, and 3 (7%) an injection. The 103 children and their parents stated the following preferences: peroral route [76 (74%) children; 89 (86%) parents], (trans-)dermal route [24 (23%); 13 (13%)], injection [4 (4%); 7 (7%)], rectal route [2 (2%); 1 (1%)], and others [(2 (2%); 2 (2%))]. Explanations for preference for the peroral route given by parents were that the peroral route would be the fastest, least painful, and most effective way of drug administration. Children stated they favored the peroral administration because they were used to it (“Drugs go in your mouth”) and it would be the least unpleasant way (“Because anything else feels disgusting to me or would hurt.”).

(B.2) Favored characteristics of peroral drugs

When asked if they preferred liquid or solid drug formulations when using peroral drug formulations, 42 (91%) of 46 parents of children aged 0–5 years said they favored liquid drug formulations, 3 (7%) preferred solid drug formulations. Of 103 children aged 6–17 years and their parents, 42 (41%) children and 47 (46%) parents preferred liquids; 38 (37%) children and 41 (40%) parents favored solid dosage forms. The most important characteristics of solid and liquid drug formulations (e.g. size, color) are shown in Table 4. The children’s choice of peroral drug formulations and of the most important characteristics of solids and liquids were independent of age (n.s.). Significant age differences were only found for the flavor of peroral drug formulations. While children who preferred sweet flavors had a median age of 10 years (Q25/Q75: 8/14, min/max: 6/17), the median age of children who preferred neutral flavors was 14 years (Q25/Q75: 11/16, min/max: 6/17; $p = 0.01$).

(B.3) Comparison of children’s and parents’ preferences concerning route of drug administration and favored characteristics of peroral drugs

Regarding the favored route of drug administration, parents’ assessment matched with their children’s answer in 68/103 (66%) cases. Answers concerning the preference for solid or liquid drug formulation matched in 62/103 (60%) cases, matches regarding the other characteristics were as follows: flavor 61/103 (59%), most important characteristic of solid peroral drug 48/103 (47%), and most important characteristic of liquid peroral drug 44/103 (43%). The matching of the parent’s and the child’s answers was independent of the child’s age (n.s.) in all categories.

(B.4) Description of the ideal pediatric drug in their own words

Answers to an open question regarding the ideal pediatric drug formulation were highly heterogeneous. Examples are shown in Table 5.

Discussion

Data of literature [13] and our own clinical experience show that the needs of children and their parents should be more carefully considered in practical drug administration. Therefore, we explored the main

causes of problems in drug handling by children and their parents. The ideas of children and their parents about how a medicine should best be administered was of particular interest in this survey. For this purpose, we performed a prospective observational study on children's and their parents' experiences of drug administration and their expectations of the ideal pediatric drug. A high proportion of children and parents reported having experienced drug-handling problems. Concerning preferred characteristics of an ideal pediatric drug, most answers were highly heterogeneous and often differed between children and their parents.

Experiences of drug-handling problems (Part A)

A high proportion of children and parents reported previous drug-handling problems in the context of pediatric drug therapy. The described problems were in the context of preparation of the drug formulation, dosing accuracy, compliance with the time interval between two administrations, and the children's acceptance of the drug.

Many parents reported problems with the preparation of oral antibiotic suspensions. They described for example that the powder clumped, that they experienced extensive foam formation, and that the fill mark for water was difficult to see due to foam. Since antibiotics are almost exclusively used for acute treatment, parents are usually not familiar with their handling. In an earlier study, a pharmacist's verbal education supported by photographic education material was much more effective in providing information on correct preparation of oral antibiotic suspensions to caregivers than the sole provision of package leaflets or education sheets [7].

A high proportion of parents reported problems in dosing liquids, especially due to dosing devices they experienced as inappropriate. This is in line with data from literature that show that more than 40% of parents made dosing errors preparing liquid medications. With advanced counseling and provision of dosing aids, those errors could be reduced [23]. However, different dosing aids show different accuracy. In particular, medicine cups that parents like to use have a reduced accuracy [17,20]. Thus, parents should be educated on the correct use of devices with a higher accuracy such as syringes. Besides, the examples provided by the parents in our study show that many devices are inappropriate with scales difficult to read, spoons too big for the child's mouth, or dosing pipettes not fitting to the bottle adapter. Those problems have to be addressed by pharmaceutical companies.

The participants of our study also described problems concerning the splitting of tablets. This is in accordance with data from literature. For example, it was shown that in spite of functional break lines, the quartering of 10 mg hydrocortisone tablets caused unacceptable dose variations. Thus, the authors of the study favor mini-tablets in adequate dosages for children [9].

Participants of our study also reported difficulties in adherence to the time intervals for medication intake due to periods of sleep or missing compatibility of the intervals with daily routines. To increase adherence as well as quality of life, physicians, parents, and their children should aim at finding time intervals that are compatible with the families' daily lives.

The participants of our study described reduced acceptance of medicines due to taste or odor issues or difficulties in swallowability. The preferences of children concerning those issues should be considered. Children's preferences about their medication are very individual. This, however, makes it difficult to achieve the goals that have been set to improve drug handling in this population.

To ensure the safety and effectiveness of a drug therapy, drug-handling problems should be addressed and, whenever possible, prevented. Studies have shown that pharmacist intervention reduces medication errors in drug administration [2,4,11,12]. The instructions should be explained in a precise, simple, and understandable way. Placebo medicinal products and pictograms can increase comprehensibility. Children's adherence can also be improved if they are actively involved in their medication process as early as possible [3].

Expectations of the ideal pediatric drug (Part B)

The peroral route of drug administration was preferred by most participants. This is in accordance with earlier studies that describe barriers to administering non-peroral formulations to children [21]. Thus, in drug development and prescription, the focus should be on peroral drug formulations.

The children's favored characteristics of drug formulations were highly individual. Only when asked about the favored taste of peroral dosage forms, an age-dependent effect could be shown. Sweet flavors were preferred by younger children while older children tended to prefer neutral flavors. This is in accordance with findings of earlier studies that infants and children showed an elevated preference for sweet flavors [5]. Considering the individual expectations of children and adolescents, ideally different formulations of an active ingredient should be available to meet the children's preferences as much as possible. Through an increased collaboration between physicians, pharmacists, and parents and their children, the choice of the most suitable drug formulation can be supported [1]. Even if not every administration problem leads to severe clinical consequences, it should be considered that drug-handling problems are closely related to a negative impact on adherence [8]. Therefore, resolving drug-handling problems can not only eliminate direct consequences of the problems themselves, but also reduce indirect consequences of decreased adherence. In the present study, we aimed at identifying problems from the perspectives of children and their parents and to elaborate their proposed solutions for future activities.

Preferences of children and parents concerning drug formulations differed in around half of the reports. Our findings are in line with earlier studies that have shown that children are indeed well able to express experiences and expectations concerning their drug therapy [10,22]. Nevertheless, physicians tend to talk to the parents when they aim at exploring the children's needs. As each child, however, has individual desires and needs, pediatricians should communicate directly with children about their drug therapy and disease management at an appropriate cognitive level. While it takes more time and empathy compared to the communication with parents, children have sophisticated information needs concerning health issues [6,18]. In addition, when it comes to the appropriate drug formulation, children need to be actively involved in the decision-making process to reach optimal acceptance and adherence with the prescribed drug therapy. As we could show, parents were not always able to properly assess their children's needs.

A particularly interesting finding of our study were single reports on proposed ideal drugs from children and parents. The suggested dosage forms ranged from the smallest possible tablets, to transdermal systems, to nasal spray, or even to mist and to utopian transmission by means of (sound) waves via headphones. The onset of action should be fast and the ideal taste ranges from neutral to pleasantly flavored, e.g. lemon or strawberry, up to savory flavors like mashed potatoes or pizza. Free choice of taste and the possibility of mixing the medicine into food were also preferred as far as taste was concerned. Red color, animal shapes, and smiley faces were mentioned visual preferences on tablets, particularly but not only mentioned by children. Parents would like to see more easy-to-read instructions for use on the package or an included anesthesia for auto-injectors.

In summary, we found a high variability in preferences that are reflected in the responses to the open question about the ideal pediatric drug. The answers were very individual and did not reveal a clear pattern. The children and their parents addressed not only practical aspects such as instructions for drug handling printed on the package, but also futuristic technological drug formulations such as the communication of effects via headphones.

Limitations

We were only able to directly address the perspective of children who had the maturity and intellectual capacity to answer the questions. In the case of younger children, only the parents' perspective could be directly explored.

Conclusion

Most pediatric patients and their parents had already experienced drug-handling problems. Expectations concerning the ideal pediatric drug formulation were highly individual and often differed between children and their parents. Thus, to improve pediatric drug therapy, the individual expectations of the patients should be considered and children should be approached directly to get to know their perspective as exactly as possible.

Abbreviations

No abbreviations used

Declarations

Funding

This study received no particular funding.

Conflicts of interest

AB reports grants from UCB Pharma GmbH and honoraria for speaking engagements from Biogen GmbH, Desitin Arzneimittel GmbH, Eisai GmbH, GW Pharma GmbH, Shire/Takeda GmbH, UCB Pharma GmbH, and ViroPharma GmbH. The other authors declare they have no conflicts of interest.

Availability of data and material

The data presented in this study are available on request from the corresponding author.

Code availability

Not applicable

Authors' contributions

BH developed the study protocol and the questionnaire, performed the questionnaire survey and the recruitment of patients, performed the statistical analysis and the interpretation of data, and wrote the manuscript.

SJ was involved in the development of the study protocol and the questionnaire, was involved in the interpretation of data, and critically reviewed and revised the manuscript.

RMM was involved in the development of the study protocol and the questionnaire, was involved in the interpretation of data, and critically reviewed and revised the manuscript.

MPN was involved in the development of the study protocol and the questionnaire, was involved in the statistical analysis and the interpretation of the data, and critically reviewed and revised the manuscript.

TB was involved in the development of the study protocol and the questionnaire, was involved the interpretation of data, and critically reviewed and revised the manuscript.

AB designed the study protocol, was involved in the development of the questionnaire, supervised the questionnaire survey, the recruitment of patients and the statistical analysis, performed the interpretation of data, and wrote the manuscript.

Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study described has been carried out in accordance with above mentioned standards and has been approved by the Ethics Committee of Medical Faculty of Rostock University, Germany (Ethics approval number: A 2019-0036).

Consent to participate

Written informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable

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Tables

Table 1: Characteristics of children's long-term medication

| Parameter | Children | Children |
|--|--------------------------|----------------------------|
| | aged 0–5 years (n=46) | aged 6–17 years (n=103) |
| Children on long-term medication n (%) | 21 (46) | 70 (68) |
| Drug formulations of long-term medication n participants (%) | | |
| Liquid peroral dosage form | 17 (37) | 14 (14) |
| Solid peroral dosage form | 4 (9) | 46 (45) |
| Powder/Granules | 3 (7) | 0 (0) |
| Injection solutions | 2 (4) | 17 (17) |
| Inhaler | 2 (4) | 6 (6) |
| Rectal foam/solution | 2 (4) | 1 (1) |
| Others | 2 (4) | 2 (2) |

Table 2: Concrete drug-handling problems described by all parents (n=46 parents of children aged 0–5 years; n=103 parents of children aged 6–17 years).

| Category of drug-handling problems | Examples of concrete problems | Examples of parents' statements |
|---|--|---|
| [n (%) parents of children aged 0–5 years; n (%) parents of children aged 6–17 years] | [n (%) parents of children aged 0–5 years; n (%) parents of children aged 6–17 years] Multiple descriptions per category were possible. | |
| Preparation of the drug [16 (35%); 25 (24%)] | Reconstitution of antibiotic suspensions [7 (15%); 11 (11%)] | <p>"The powder clumped."</p> <p>"Extensive foam formation."</p> <p>"Fill mark for water difficult to see due to foam."</p> |
| Dosing [28 (61%); 34 (33%)] | Difficulties in dosing liquids, especially due to inappropriate dosing devices [26 (57%); 19 (18%)] | <p>"Scaling of the dosing syringe not suitable for the volume to be measured."</p> <p>"Dosing spoon is too big for the child's mouth."</p> <p>"The scale of the measuring cup is not easy to read."</p> <p>"Dosing pipette does not fit to the bottle adapter."</p> |
| | Difficulties in dosing tablets, especially in tablet splitting [4 (9%); 14 (14%)] | <p>"Tablet without break notch had to be divided for correct dose."</p> <p>"Despite tablet splitter, the tablets are always broken into unequally-sized pieces."</p> |
| Compliance with the time interval [13 (41%); 51 (50%)] | Child was asleep [10 (22%); 23 (22%)]. | <p>"Child sleeps even though medication should be given."</p> <p>"At night, inhalation and antibiotic administration is difficult, because you always have to wake the child up."</p> |
| | Daily routine was not compatible with the time interval for drug intake [4 (9%), 15 (15%)] | <p>"Child is at sports."</p> <p>"Child is with another caregiver."</p> <p>"Child has spontaneously been out late in the evening."</p> |
| Acceptance [39 (85%); 48 (47%)] | Limited acceptance of liquids, especially due to taste or odor issues [37 (80%), 24 (23%)] | <p>"Liquids were spat out again."</p> <p>"Liquids were completely refused by pinching the mouth shut."</p> <p>"Liquid could not be administered because it was much too sweet."</p> |

Decreased acceptance of tablets, especially due to problems in swallowability [3 (7%), 13 (13%)]

“Refused due to size and taste.”

“Child vomited tablet up (too big, too bitter).”

“Tablet was too big to swallow.”

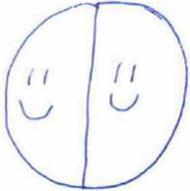
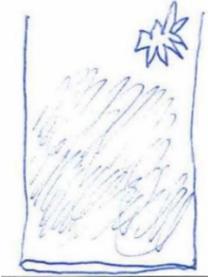
Table 3: Examples of drug-handling problems described by children (n=103 children aged 6–17 years)

| Category of drug-handling problems [n (%) of children] | Examples of children's statements |
|---|--|
| Preparation of the drug formulation [16 (16%)] | "Cap of prefilled syringe comes off with difficulty sometimes." |
| | "Capsule did not open." |
| | "Needle bent while attaching to insulin pen. Belly was slit bloody with needle." |
| Dosing [11 (11%)] | "The tablet had a division aid, but you couldn't divide it." |
| | "Dosing syringe did not fit." |
| | "Dosing spoon was stupid. Bottle opening too big. Everything spilled out." |
| Compliance with the time interval [38 (37%)] | "I didn't count it right." |
| | "I forgot to take medicine in the evening on a class trip." |
| | "In the evening when you go out, it's sometimes difficult because of food and medication." |
| | "Would have liked to eat something, but couldn't because of the medication." |
| Acceptance [32 (31%)] | "I was out and did not have the tablets with me." |
| | "There was a lot of stress in the morning before school, and then I forgot it." |
| | "During the first few years, I didn't want to inject myself in public." |
| | "Syrup doesn't taste good." |
| | "Tablets and capsules difficult to swallow. Now capsules are opened and stirred in." |
| | "The tablets were very bitter and came out with the contents of my stomach." |
| "Too big tablets." | |
| "Because it hurts." [note: insulin injections] | |

Table 4: Favored characteristics of peroral drug formulations according to participants' answers to a questionnaire with pre-set answers to tick. Multiple answers were not intended, but if participants were not able to choose only one answer, all chosen answers were considered for the evaluation.

| | Parents of children aged 0–5 years (n=46) | Children aged 6–17 years (n=103) | Parents of children aged 6–17 years (n=103) |
|--|--|-------------------------------------|--|
| Preference of solid or liquid peroral drug formulations n participants (%) | | | |
| Liquid | 42 (91) | 42 (41) | 47 (46) |
| Solid | 3 (7) | 38 (37) | 41 (40) |
| Does not matter | 0 (0) | 23 (22) | 15 (15) |
| Others | 1 (2) | 0 (0) | 0 (0) |
| Most important characteristic of solid peroral drug formulations n participants (%) | | | |
| Size | 29 (63) | 58 (56) | 83 (81) |
| Flavor | 7 (15) | 37 (36) | 25 (24) |
| Color | 5 (11) | 12 (12) | 7 (7) |
| Shape | 2 (4) | 12 (12) | 13 (13) |
| Label on the surface | 3 (7) | 2 (2) | 4 (4) |
| No answer | 0 (0) | 1 (1) | 0 (0) |
| Most important characteristic of liquid peroral drug formulations n participants (%) | | | |
| Volume | 15 (33) | 21 (20) | 17 (17) |
| Flavor | 27 (59) | 73 (71) | 76 (74) |
| Color | 0 (0) | 4 (4) | 4 (4) |
| Texture | 1 (2) | 6 (6) | 7 (7) |
| Smell | 3 (7) | 16 (16) | 30 (29) |
| Preferred flavor of drug n participants (%) | | | |
| Sweet | 24 (52) | 55 (53) | 46 (45) |
| Neutral | 21 (46) | 39 (38) | 60 (58) |
| Bitter | 1 (2) | 0 (0) | 0 (0) |
| Does not matter | 0 (0) | 9 (9) | 1 (1) |

Table 5: Examples for specific expectations of parents and children regarding the ideal pediatric drug

| | | |
|---|---|--|
| Children | | |
| "The main thing is that it tastes good (raspberry or strawberry flavor). If it tastes good, everything else does not matter." Girl aged 11 years with epilepsy | | |
| "It doesn't matter, the main thing is a quick onset of action." Girl aged 16 years with migraine | | |
| "It would be a liquid that you could mix into any food and it wouldn't be noticeable. There are all kinds of flavors" Girl aged 12 years with condition after pilocytic astrocytoma | | |
| "A very simple plaster that cures fever in 30 minutes." Boy aged 16 years with diabetes mellitus type 1 | | |
| "Preferably round and as small as possible. Maybe in bright red." Girl aged 12 years with tension headache | | |
| "Ingestible insulin or an artificial pancreas that delivers insulin itself." Boy aged 14 years with diabetes mellitus type 1 | | |
| "It would be blue. It would also taste and look like mashed potatoes." Girl aged 11 years with migraine | | |
|  |  |  |
| "A tablet with smiley faces that makes you happy." Girl aged 16 years with epilepsy | "A water with a taste of my choice where you can see what you have." Girl aged 9 years with vertigo | "A drug that helps against everything. A capsule." Boy aged 8 years with epilepsy |
| Parents | | |
| "Important information about the administration should be written on the outside, so that you don't have to read the package insert. A hypospray like the one used in Star Trek would be ideal: injection under the skin with a fine needle so that you don't feel anything (similar to a mosquito bite). Applicator has a local anesthetic on the front to numb the injection site. Applicator has information about the child (age, weight) and the dosage, so you only have to hold the device at the application site." | | |
| "Put headphones on the children. Drugs are transmitted via sound waves. Electricity can be used to directly control cells (or target sites)." | | |
| "Dosing pipette should be designed in the shape of an animal, e.g. elephant with trunk. There should be child-friendly symbols/pictures on the packaging. Liquid. Pink and red appearance. Small 'give-away' in each package." | | |
| "Like Star Trek with a painless gun. Or even inhalable fog." | | |
| "Nasal spray instead of insulin doses." | | |
| "Small tablet. Good to swallow. Everything else should be as neutral as possible (taste, smell)." | | |

“Like Smarties. With rounded corners. Good flavor (lemon, for example). Colorful.”