Children's multiple vitamins: overuse leads to overdose

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A suburban Ontario community hospital encountered 21 ± 1 overdoses of children's multiple vitamins yearly between 1978 and 1981. Of these, 35% involved one particular cartoon character preparation. Parents were surveyed to determine whether this particular preparation resulted in a disproportionate number of accidental overdoses. However, the use of vitamins with a cartoon character format did not lead to a greater risk of overdose than did conventional preparations. Of the 1051 families who had given multiple vitamins to their children 34 (3%) had experienced an overdose. The number of vitamin preparations used by each family was the most powerful determinant of overdose ($p < 0.001$). The risk of accidental overdose increased from 1.5% with one multiple-vitamin preparation to 8% with four or more preparations. Among all the variables examined, exposure was the most important element in the risk of multiple-vitamin overdose.

Dans un hôpital public de banlieue en Ontario, de 1978 à 1981, le nombre annuel des cas d'ingestion excessive par des enfants de préparations multivitaminées a été de 21 ± 1. Comme, dans 35% des cas, il s'agissait d'une préparation dont le conditionnement illustre des personnages de bande dessinée, on a fait une enquête auprès des parents pour savoir si un tel conditionnement amène un plus grand nombre de prises excessives que les autres. On n'a pas trouvé que ce fût le cas. Parmi 1051 familles qui ont utilisé des produits multivitaminés, la prise excessive par des enfants est arrivée chez 34 (soit 3%). Le facteur le plus significatif de la survenue de celle-ci ($p < 0,001$) est le nombre de tels produits utilisés dans la maison: le risque passe de 1,5% pour un seul produit à 8% pour au moins quatre produits. De tous les facteurs qui ont été examinés, le plus important est donc la présence des produits multivitaminés à la portée de l'enfant.

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Between 1978 and 1981 many acute overdoses of children's multiple vitamins were seen in the emergency department of a suburban Ontario community hospital. Many of the preparations involved were sweetened multiple vitamins that were shaped as cartoon characters. These dietary supplements customarily contain the following recommended daily nutrient intake for children: vitamin A, 1500 IU; vitamin D, 400 IU; and vitamin C, 40 mg.[1] Treatment was usually necessitated because of the iron content, which could be as much as 15 mg of elemental iron per tablet, or 1500 mg per bottle of 100 tablets. A dose of 60 mg/kg of elemental iron is viewed as toxic and 200 mg/kg as lethal. The question was posed as to whether the cartoon format of the vitamin preparations seduced children to ingest large quantities. It became essential to delineate the overall use of vitamin supplements in the community to see whether there was a disproportionate number of overdoses of vitamins with a cartoon format.

Patients and methods

A school survey of multiple-vitamin use was performed to obtain an appropriate cross-section of a well-child population. The research department of the Halton Board of Education distributed a survey questionnaire to children in the public schools in Burlington, Ont. Burlington is a homogeneous middle-class suburban community with a population of 114 000 and is located on the north shore of Lake Ontario between Toronto and Hamilton. At the time of the survey the city was served by a regional poison control centre at the Joseph Brant Memorial Hospital; the centre provided the statistics for hospital emergency department visits resulting from multiple-vitamin overdoses. All of the family physicians and pediatricians serving Burlington are affiliated with the hospital and were available for a separate survey of physicians' prescribing habits and attitudes about the use of multiple vitamins.

Hospital emergency department survey

During the 4-year period 1978 to 1981 all the records of visits to the emergency department of Joseph Brant Memorial Hospital were examined. This emergency department serves a catchment area of 140 000 people that mostly corresponds to the Burlington community school district.[2] There were approximately 50 000 emergency department visits per year; of these, an average of 186 ± 43 were for accidental poisonings in

children under 13 years of age. Children were assessed by the casualty officer on call and treated according to his or her judgement. The children who were admitted to hospital were customarily attended by one of the three consulting pediatricians serving the community. All the records of multiple-vitamin overdose in children under 16 years of age were reviewed, and, when available, the name of the product involved was recorded.

Parental survey

In May 1982, 1276 questionnaires were distributed to all the children in kindergarten and the first grade of the Halton School Board, Burlington District. The questionnaires were to be completed by a parent and returned to the school within 2 weeks. The parents were informed by an introductory letter that participation was voluntary but that nonrespondents would be contacted by the school. A colourful poster on child safety was enclosed with the letter in an attempt to improve the response rate. Returned questionnaires were collated by each school and forwarded to the research team.

Physician survey

Family physicians provide most of the primary health care for children in Burlington. In 1982 there were only 2 primary care pediatricians and 3 consulting pediatricians, whereas there were 78 family physicians. Questionnaires were distributed to all 80 primary care physicians in October and November 1982. They were redistributed at 2-week intervals three times to achieve a satisfactory response rate.

Table I—Multiple-vitamin preparations used by 1051 families

Preparation	No. (and %) of families*
Flintstones	512 (49)
Tri-Vi-Sol, Tri-Vi-Flor, Poly-Vi-Sol or Fer-In-Sol	279 (26)
Chocks	202 (19)
Unspecified	74 (7)
Vitamin C	45 (4)
Cod or halibut liver oil	11 (1)

*Some families used more than one preparation.

Results

Hospital emergency department survey

Between 1978 and 1981, 84 children under 16 years of age were seen in the emergency department because of an overdose of multiple vitamins. One particular multiple-vitamin preparation, Flintstones, was involved in 35% of the cases. Admission to hospital was necessary in 17 cases, usually because of concern for iron toxicity. In 40% of the 17 cases the serum iron level exceeded the total iron binding capacity, and provocative chelation was started with deferoxamine administered intramuscularly. There were no deaths, and all the children were released within 1 day after admission.

Parental survey

Of the 1276 questionnaires that were distributed to the kindergarten and first-grade schoolchildren 1173 (92%) were returned. Multiple-vitamin use had been ubiquitous. Only 10% of the children had not been given multiple vitamins at some time. At the time of the survey 34% of the parents were giving multiple vitamins to their children. Another 37% indicated that they had given multiple vitamins in the winter; thus, up to 71% of the children may have been taking vitamins during the peak winter months. Only 29% of the parents reported that the vitamins had been prescribed by a doctor.

Flintstones, the multiple-vitamin preparation responsible for the largest number of emergency department visits, was also the brand most commonly used by the families (Table I). However, this brand accounted for a smaller proportion of overdoses relative to its use in the community (32% v. 48%; $p < 0.07$, according to chi-square analysis) (Table II). It can be seen from Table II that chewable preparations were no more likely than "standard" preparations to be involved in an overdose.

Of the 1051 families 34 (3.2% of user families) had experienced an accidental overdose of multiple vitamins. In 12% of these families more than one child had been affected. The mean age at the time of overdose was 3.3 years. Table III shows the actions taken by the families when they became aware of the overdose. Eleven (32%) of the children were eventually seen at a hospital; emesis was induced in 10, and 3 were admitted; these 3 later suffered side effects, which were not specified.

There were no differences between the 34 families

Table II—Comparison of multiple-vitamin use and overdose among 1051 families

	No. (and %) of families using multiple vitamins			
Preparation	Total (n = 1051)	Reporting overdose (n = 34)	χ^2 values	Level of significance*
Flintstones	512 (49)	11 (32)	3.11	$p < 0.07$
Tri-Vi-Sol, Tri-Vi-Flor, Poly-Vi-Sol or Fer-In-Sol	279 (26)	11 (32)	0.71	NS
Chewable tablets	590 (56)	16 (47)	1.61	NS

*NS = not significant.

that experienced an overdose and the 1017 that did not with respect to number of children, frequency of vitamin use, proportions of children for whom vitamins had been prescribed and duration of vitamin use. However, the families that experienced an overdose used a mean of 2.6 ± 1.3 different types of vitamin preparations, whereas the families that did not experience an overdose used a mean of 1.7 ± 1.1 ($p < 0.001$). Fig. 1 shows the steadily increasing risk of overdose with each additional vitamin preparation used by the family. The risk increased from 1.5% with one multiple-vitamin preparation to 8.1% with four or more preparations.

Physician survey

The suggestion that increasing exposure to multiple vitamins is the greatest determinant of overdose led to our analysis of physician attitudes and prescribing patterns. Seventy-four (92%) of the 80 physicians returned the questionnaire. The results indicated a wide variety of practices. Vitamin supplementation for infants was recommended by 57% of the physicians. By contrast, only 27% recommended multiple-vitamin use for children older than 1 year; of these, 13 did so to provide fluoride. This percentage is close to that of parents who reported that vitamin supplementation had been recommended by their physician.

Of the 74 physicians, 68 (92%) reported that the parents had requested vitamin supplements for their children. Only 4% of the physicians denied that they had received such requests. The physicians were asked to detail the perceived reasons for the requests. The results are detailed in Table IV. The individual reasons were weighted according to the physicians' estimate of the concerns most frequently expressed. "Picky eating" among toddlers received a score of 200, compared with "frequent infections" and "unbalanced diet", which received scores of 139 and 136 respectively.

Table III—Actions of 34 families experiencing multiple-vitamin overdose

Action	No. (and %) of families
Telephoned poison control centre	17 (50)
Telephoned doctor	15 (44)
Visited hospital	11 (32)
Emesis induced	10 (91)
Child admitted	3 (27)
Telephoned hospital	9 (27)
Visited doctor	3 (9)

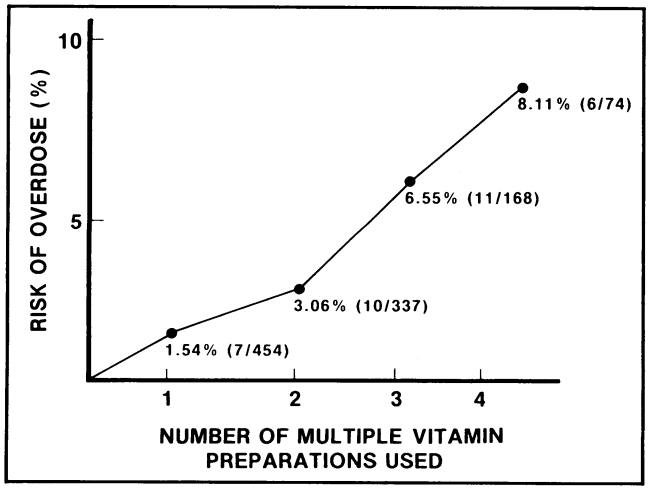

Fig. 1—Risk of overdose according to numbers of multiple-vitamin preparations used.

Discussion

Our study and another recent Canadian survey[3] reveal a vast use of multiple vitamins by children, unlike usual North American patterns of vitamin use by children.[4,5] Yet several detailed nutrition studies in Canadian children over the last decade have failed to show any widespread evidence of nutritional deficiency.[6-8] When nutrition problems occur in specific subpopulations they are usually the result of a deficit of overall energy or protein intake rather than of micronutrients.[7] In fact, Yeung and coworkers,[8] in an extensive prospective study of 300 children in Montreal and Toronto, found that the average 18-month-old child ingested 600% of the recommended dietary intake of vitamin C (120 mg) and 434% of that of vitamin A (5794 IU). Only iron intake came close to being marginal, with 89% (7.1 mg) of the recommended dietary intake being ingested.[8]

Neither the Canadian Paediatric Society[9] nor the Department of National Health and Welfare[10] has recommended routine vitamin supplementation for children over 1 year of age. Yet vitamin supplements are used extensively. It seems that much of the demand for supplementation is generated out of parental anxiety over toddlers' normal eating patterns. Physicians feel they are pressured to prescribe or recommend vitamins. In this study we did not evaluate the role of advertising in influencing parental attitudes to the necessity for multiple-vitamin supplementation.

We found that the particular format of the vitamin did not appear to induce overingestion. On the contrary, two of the overdoses involved cod liver oil, which indicates that children are capable of ingesting anything they can get their hands on. Thus, exposure becomes the critical issue.

It has previously been shown that the use of child-resistant containers can reduce the frequency of multiple-vitamin overdose by half.[11] This would explain our observation that there were proportionately fewer over-

Table IV—Parents' reasons for requesting multiple vitamins for their children, according to the 68 physicians responding

Parents' reason	No. (and %) of physicians	Weighted score*
Picky eating	55 (81)	200
Frequent infections	50 (74)	139
Unbalanced diet	45 (66)	136
Winter stress	35 (51)	75

*The physicians ranked the frequency of parental complaints to develop a weighted score that reflected parental anxiety.

doses with Flintstones than might be expected from their widespread use in the community. However, despite their child-resistant containers, Flintstones were involved in the largest number of reported overdoses; therefore, less needless supplementation rather than safer packaging seems to be the answer.

In this particular community we were able to study several facets of the issues posed by vitamin supplementation in children. While none of the perspectives were strictly comparable, there was good agreement between the brands of multiple-vitamin preparations reported by the parents to be involved in overdoses and those that were implicated in cases seen in the emergency department.

The information we received from the parents suggests that only a small proportion of overdoses are reported to poison control centres. It is likely, however, that some of the parents either forgot or were reluctant to report an accidental overdose, since it might imply neglect or lack of supervision. Despite these factors favouring under-reporting, multiple-vitamin overdose was a recurring problem that far outweighed any clinically apparent nutritional deficiency. (During the study period no children were treated in the hospital for nutritional deficiency unrelated to an underlying disease.) The mere exposure to multiple-vitamin preparations emerged as the single most important factor leading to overdose. This was true for the community as a whole and for individual families in particular.

Viets and colleagues[12] and Krenzelok and Hoff[13] have drawn attention to the particular problems posed by preparations of multiple vitamins with iron. These agents were responsible for the greatest number of visits to emergency departments and hospital admissions. Since our study was undertaken the Food and Drug Directorate of the Department of National Health and Welfare has developed guidelines for limiting the amount of iron in a single bottle of multiple vitamins with iron to 250 mg.[14] These guidelines have not yet been incorporated into mandatory regulations to correct the liability of potentially lethal products.

Conclusion

Advocacy of multiple-vitamin supplementation for toddlers has traditionally been defended as nutritional insurance without additional risk.[4] Our observation of multiple-vitamin overdoses directly proportional to exposure challenges the wisdom of this logic. If studies of Canadian children show no risk of vitamin deficiency, why should these children be exposed to the unnecessary risks of overdose? Physicians should examine the reasons parents give for requesting multiple vitamins for their children; if there is no particular reason to recommend multiple vitamins, physicians ought to counsel the parents about some of the problems we have indicated. Families that use many vitamin preparations seem at particular risk. This population should be the target of special attention and counselling regarding safety precautions from physicians, pharmacists, nurses and nutritionists.

The only vitamin supplement that is currently recommended for children is vitamin D, for breast-fed infants, the object being to reach a very small population at risk.[15] However, recommendations for vitamin supplementation in infants likely condition parents to continue supplementation for older children, thus exposing many more children to vitamin overdose than were ever at risk of rickets. Such recommendations probably contribute to the public's overemphasis of the benefits of vitamin use and its general lack of understanding about what's important for the nutrition of children. If these recommendations do more harm than good they should be changed.

The extent of multiple-vitamin use in our study demonstrates the public's preoccupation with micronutrients. Unfortunately, the use of vitamin supplements will not address the major problems confronting Canadian children: excess energy intake in inactive children, and excess intake of salt and sugar.[6] Adequate fibre intake, fibre being the most commonly deficient dietary component, will only be provided by a varied, well balanced diet. Food rather than pills should continue to be emphasized in all forms of nutrition education.

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