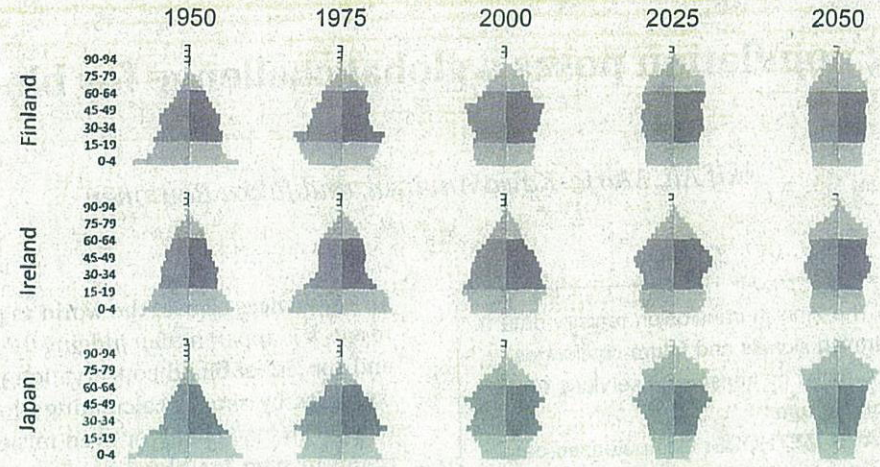

Fig. 1. Examples of population pyramids for Finland, Ireland, and Japan for different age groups based on WHO statistics years 1950 to 2000 and prognosis for 2025 to 2050. The left side of the pyramid indicates the proportion of males and the right side of females in the country.

operations, test results, and blood components as well as on transfusions. For data security reasons, a coding computer program (DWcrypt, Datawell Oy, Espoo, Finland) encrypted patients' personal identification numbers using different passwords for each hospital district. The data were analyzed with the analyzer reporting program (Ecomed, Datawell Oy) and a statistical software package (SPSS, SPSS, Inc., Chicago, IL). The simulation analyses are based on red blood cell (RBC) usage in Finland. Per-capita usage was calculated by dividing the annual RBC use of persons at certain age with the total number of living individuals of the same age. We simulated the RBC usage according to the Finnish practice on different age groups but the population demographics from other countries, which can be presented as population pyramid, that is, distribution of different age groups within a population. Some examples of population pyramids for Finland, Ireland, and Japan are shown in Fig. 1. For the population demographics, the data from Statistics Finland and WHO were used. The data for Finland consist of population statistics on the size and structure of the permanently resident population and related changes, such as births, deaths, marriages, migration, as well as population projections. For the other countries the WHO (United Nations, Department of Economic and Social Affairs, Population Division, http://www.un.org/esa/population/unpop.htm) data consist of world population prospects, population by age groups, medium-fertility assumption based on UN Population Division's quinquennial estimates and projections.

RESULTS

The Finnish data demonstrate a marked increase in RBC consumption with increasing age among recipients, beginning at around 50 years of age. The elderly consistently have a much higher RBC consumption than younger people: 70- to 80-year-olds have an eightfold higher RBC consumption than 20- to 40-year-olds (Fig. 2). Many other countries show similar trends in RBC usage.[2-4]

According to Council of Europe 2004 statistics, the use of RBC products varies considerably among the European Union member states (4-73 per 1000 inhabitants; mean, 37 per 1000 inhabitants).[5] A large part of the variation in RBC use per capita can be explained by the age distribution of the different populations and not by the different national and regional treatment policies and protocols used. Figure 3 shows the simulated RBC usage per capita in selected countries in 1950 to 2050, based on historical and predicted age distribution figures (from the UN Population Division) and the age-distributed variation of blood usage (as RBC units) in Finland between 2002 and 2006. This simulation assumes the same transfusion practices for each country. In Finland, 55% of RBCs are used for patients treated for surgical diagnoses or interventions, whereas 45% are used during conservative treatment periods. For the platelets, the proportions are 32 and 68%, respectively. Of all blood used in Finland, 21% goes for treatment of hematologic malignancies (ICD-10 classes C81-C97), 16% for treatment of cardiac and circulatory system diseases (I00-I99), and 12% for the treatment of tumors (C00-C80 and D00-D48). The population trend during the period 1950 to 2050 predicts an increase in RBC requirements in most countries. Very few countries exhibit a period of decreasing need for simulated RBCs, and since 1990 the simulated RBC use shows increase in all the countries.

We have calculated the blood-dependency ratio in selected countries for the period 1950 to 2050, describing the number of age-noneligible donors that each

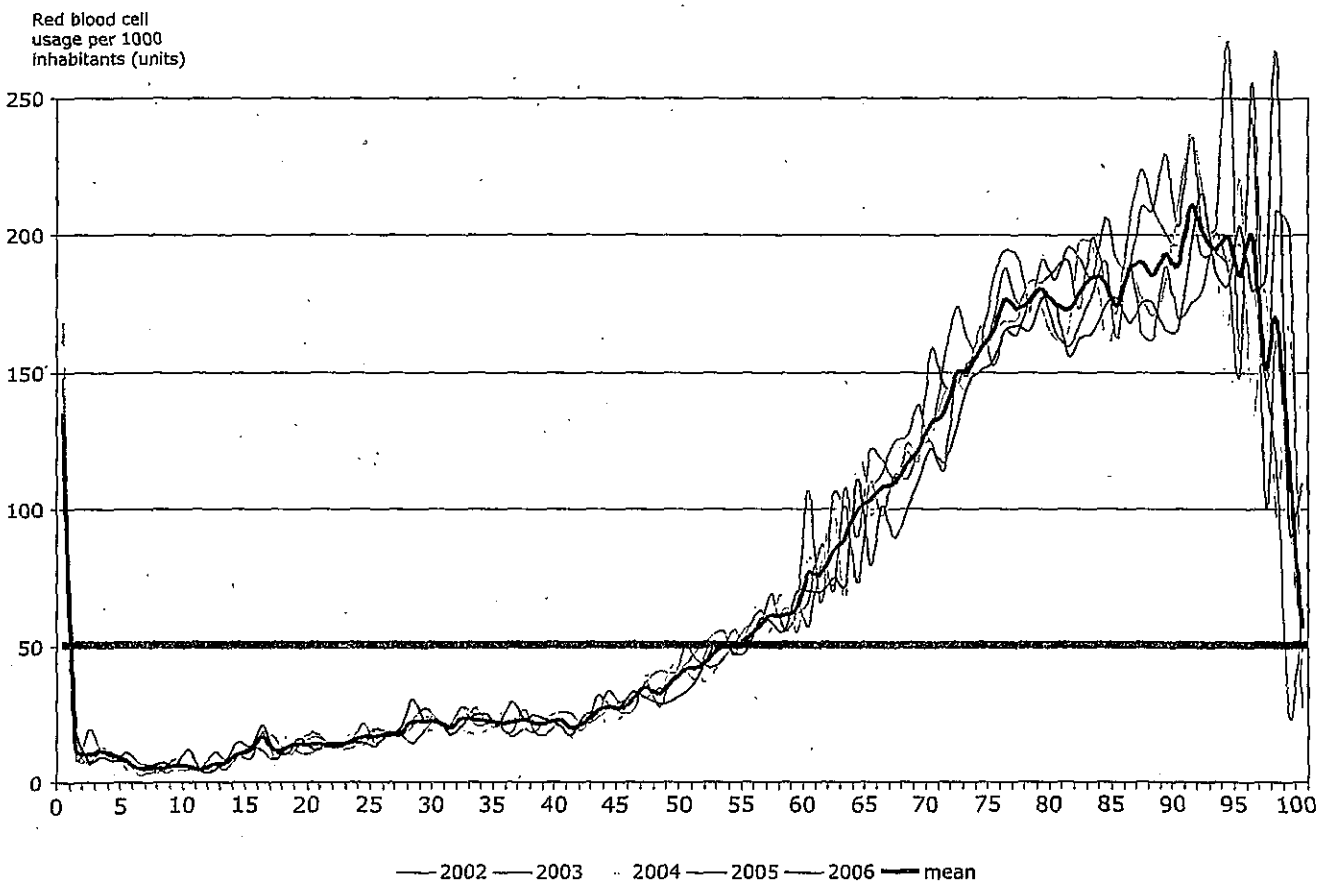

Fig. 2. RBC usage per capita by age in Finland 2002 to 2006. Current annual RBC usage in Finland is 50 units per 1000 inhabitants.

age-eligible donor needs to support in addition to him/herself (Fig. 4). Most countries had a local maximum during the 1960s and 1970s and a subsequent decline until the 1990s.

In conclusion, the increasing proportion of elderly people in most countries will result in a major increase in the demand for RBC products globally, unless treatment modalities can be improved and, consequently, the dependence on RBC transfusions decreased. One might argue that future elderly populations will be healthier than their current counterparts. However, the Finnish data have not shown a decrease in the transfusion needs of elderly people. For the prevalence of the diseases treated with transfusions, we compared WHO data on mortality and morbidity (http://www.who.int/whosis/whostat/2009/en/index.html). For cardiovascular diseases, which is the second largest diagnostic group among transfused patients in Finland, the countries selected for the simulation analyses have similar age-standardized mortality rates. Two exceptions are Russia and Poland, where the mortality rates for cardiovascular diseases are three- and twofold compared with Finland (Table 1). The age-standardized mortality rate for injuries is 64 per 100,000 population in Finland, thus higher than most of the countries analyzed in this study. However, the causes for death due to injury in Finland are more often connected to toxicity or suicidal behavior than traffic accidents or other such injuries where transfusions would be necessary.[6]

The observed difference of 42% between the lowest (Ireland, 41 RBC units/1000 population) and highest (Japan, 58 RBC units/1000 population) country in this simulation is fully explained by the different national population pyramid. It is clear that although the national data on RBC use are a useful indicator, they are not sufficient to compare transfusion practice among countries. The problem posed by the projected increased demand on blood services due to the aging population is exacerbated by the concomitant decrease in the size and proportion of the population eligible to donate blood in developed countries. Globally, the proportion of people aged more than 65 years in the population is projected to increase from 7.7% in 2010 to 16.5% in 2050,[7] with the highest increases expected in Eastern Europe and developed countries.

The blood-dependency ratio, describing the number of noneligible donors that each eligible donor needs to support in addition to him- or herself, shows that in most