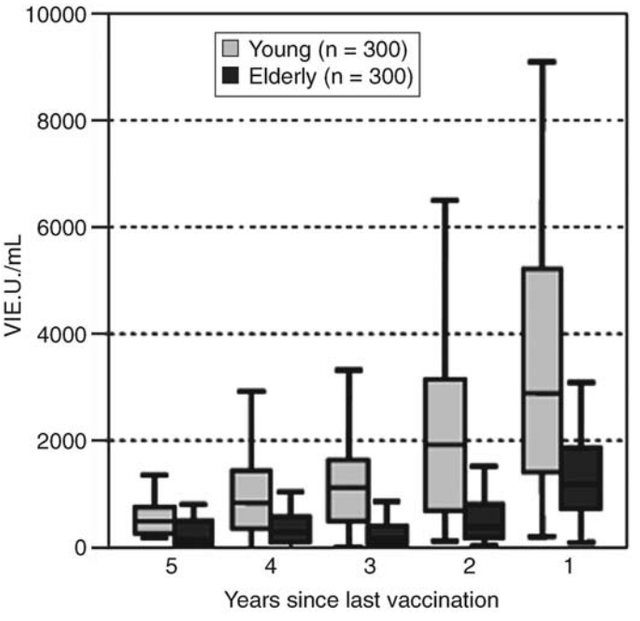

Figure 2 Antibody titers (Vienna Units/milliliter) against tick-borne encephalitis in young (<35 years; $n = 300$) and elderly persons (>60 years; $n = 300$) dependent on the time point of the last vaccination. In contrast to young persons, elderly persons had already significant lower antibody concentrations after one year. Antibody titers of >100 VIE U/mL are considered to be protective.

patients during their life, especially in old age when immunological competence declines. Tuberculosis is frequently diagnosed with delay in elderly persons because of an atypical clinical manifestation, which leads to enhanced morbidity and mortality. Further difficulties include the increased emergence of multiple drug-resistant strains with higher transmissibility and the poor efficacy of the current vaccine Bacillus Calmette-Guérin (BCG) in preventing the establishment of latent tuberculosis or reactivation of pulmonary disease in adults and the elderly. The BCG vaccine is therefore not recommended in many countries with a low incidence of tuberculosis. However, new tuberculosis vaccines have entered clinical trials and may also induce a strong cell-mediated immune response, which is essential to protect from an intracellular pathogen such as *M. tuberculosis*.

Vaccinations against tetanus, diphtheria, poliomyelitis, and pertussis have been administered on a routine basis since decades and have led to a significant reduction of morbidity and mortality. However, antibody levels after vaccination against tetanus, diphtheria, and pertussis decrease more rapidly in elderly persons (8,9). In contrast, longer-lasting protection and good responsiveness to boosting in spite of low antibody titers to poliomyelitis can be expected following exposure to live vaccine earlier in life (9).

Travel Vaccines

Because of the increased mobility of the elderly, 5% to 8% of travelers in tropical areas are of advanced age, and this number is still increasing. Thus, the efficacy of travel vaccines protecting from typhoid and yellow fever, hepatitis A and B, tick-borne encephalitis (TBE), Japanese encephalitis, and rabies is of increasing importance for the elderly who are dependent on a limited T- and B-cell repertoire that does not guarantee full responsiveness to new antigens. Nevertheless, in vitro experiments have demonstrated that T cells from elderly persons can still be stimulated by neoantigens, at least to the recombinant Etr protein of TBE virus and rabies virus (10).

Hepatitis A is an acute disease of the liver caused by a nonenveloped virus belonging to the Picornaviridae family, with an estimated 1.5 million new infections per year worldwide. Hepatitis A vaccination is routinely recommended when traveling to tropic and subtropic areas. Clinical illness after hepatitis A infection is usually mild in young individuals, but the risk of severe infection and mortality increases with age. After combined hepatitis A/B vaccination, seroprotection was 92% in young adults (<40 years) compared with 63% for elderly persons (>60 years). It is therefore recommended to assess antibody levels in the elderly, as boosters have shown to be efficient in the case of vaccination failure (11).

Another travel-related disease is yellow fewer, which is endemic in Africa and South America. Older adults possess an increased risk of severe disease, and mortality rates are highest in this age group. Because of the increased use of yellow fever vaccine in elderly persons, advanced age turned out to be a potential risk factor for severe adverse effects and even death. For elderly travelers, the risk for severe illness and death caused by yellow fever infection should therefore be carefully balanced against the risk for systemic illness due to the yellow fever vaccine (12).

TBE is one of the most dangerous neuroinfectious diseases in Europe and Asia and is responsible for up to 12,000 cases of

Table 1 Vaccines Recommended for Routine Use in the Elderly

Disease	Available vaccine types	Vaccine efficacy[a]	Recommended booster intervals
Influenza	Split protein, subunit, virosome	<50%	Annually
Pneumonia	Conjugated polysaccharide	<65%	5–6 years
Tetanus Diphtheria Pertussis	Toxoid Toxoid Accellular	>84%[b]	5–10 years
Poliomyelitis	Inactivated virus	>99%[c]	10 years
Herpes zoster[d]	Live-attenuated virus	<61%	ND

ND, not determined.
[a]Overall vaccine efficacy in persons older than 60 years.
[b]Vaccine efficacy after booster vaccination against tetanus, diphtheria and pertussis.
[c]Vaccine efficacy after booster vaccination with an inactivated poliomyelitis virus, while for priming a live-attenuated vaccine was used.
[d]Considered for future routine use in elderly persons.