
Epidemiologic Aspects

Heinrich Burkhardt

Definition of the Elderly

A common definition (World Health Organization 2011) describes elderly individuals as persons aged 65 and over. A previous definition given by the WHO even defined persons only 60 or more years old as elderly, but this cutoff is not generally accepted. In this context, it is necessary to discuss the definition of age. The definition of an calendarian cutoff for defined age groups merely depends on social consensus and not primarily on physiological changes that may occur even years before. Age-associated physiological changes in the endocrine system or in lens elasticity may start much earlier even in healthy subjects: between age 40 and age 45 for the endocrine system and during puberty for lens elasticity. A reliable and valid threshold value for significant changes in physiology cannot be calculated and applied due to a great variety of interindividual aging patterns and courses.

Within the large group of elderly individuals, persons at age 80 years and older may form a special subgroup presenting with increased prevalence rates of typical geriatric problems; for that reason, they may be defined as belonging to a separate age group—some call them the fourth

age. Octogenarians (more so even older people) show a significant decline in key functionalities such as locomotion, continence, and cognition; therefore, functionality and impairment are a major topic when considering health-related aspects of high age.

Methodological Aspects

Epidemiologic data comprise a variety of data sources. Global trends mainly rely on national census data and international data platforms such as U.N. organizations or the WHO. For many countries, such data provide reliable information on the age distribution of the population, life expectancies, and regional and global trends for defined age groups.

Functionality and impairment data or descriptions of special barriers are often not sufficiently represented in census data; health insurance organizations or population-based large scale cohort studies may provide more sophisticated data sets. Remarkable regional differences due to the heterogeneity of health care systems and epidemiologic approaches need to be considered. Therefore, an international comparison of prevalence data has to utilize global surveys such as those by the WHO. The WHO provides data retrieved by the World Health Survey, which include entries on the prevalence of functional limitations among the elderly population in different countries. Unfortunately, not all countries are participating in this survey for a variety of reasons,

H. Burkhardt (✉)
IVth Department of Medicine, Geriatrics, University
Medical Centre Mannheim, Theodor-Kutzer-Ufer 1-3,
68167 Mannheim, Germany
e-mail: heinrich.burkhardt@umm.de

and not all standardized questions are suitable for all regions, rendering a global comparison difficult to impossible. There is no global consensus how to measure functionality best, and frameworks developed in the United States and European countries will not fit situations in developing countries despite their wide acceptance in the scientific literature. This may also explain the paucity of regional data published from countries outside Europe and the United States.

Identifying data on general prescription rates of drugs in the elderly is even more challenging. In most countries, systematic drug surveys are lacking, and prescription rates can only be estimated from general consumption rates or total redeemed prescriptions, but the information is usually not stratified for defined age groups or individual diseases. Therefore, data on polypharmacy are often lacking or ambiguous. In some countries, national health surveys comprise medication data; however, these data are not published in an appropriate way to allow for calculation of prescription rates in the entire elderly population and are mostly restricted to subpopulations with defined diseases or health problems. For that reason, a global comparison of polypharmacy prevalence and prescription rates is even more challenging. Obviously, in developing countries access to pharmacotherapy is restricted due to financial and infrastructural limitations and a global and transcultural comparison of drug prescription patterns cannot be made with certainty. Finally, local and regional drug availability may be variable due to differences in licensing and adds to the complexity of drug analysis. Coding and grouping different drugs may also widely vary across different regions even if countries may be comparable for demographic, political, and socio-cultural aspects.

In the European context, the Berlin Aging Study (BASE) appears as the most thorough population-based analysis concerning drug prescription in the elderly (Baltes and Mayer 2001). The BASE investigators not only performed a detailed analysis of prescription rates but also analyzed over-the-counter (OTC) drugs and evaluated appropriateness of individual prescriptions by reevaluating the individual disease pat-

terns. Moreover, symptoms possibly associated with adverse drug reactions (ADR) were analyzed for each subject.

General Aspects

In Western countries and some developing countries (e.g., Brazil), the proportion of elderly in the population steadily increased over the past decades and the age group of people 80 years and older may even represent the most rapidly expanding subpopulation (e.g., Germany). Simultaneously, life expectancy of younger and middle-aged people is also increasing. Table 1 summarizes recent data from U.N. calculations and estimations. Although the current life expectancy at birth still differs markedly between the United States and a typical European country on the one hand and Brazil and India on the other, it is noteworthy that life expectancy of 65- or 80-year-old persons becomes similar for these countries.

As mentioned, a global perspective concerning drug prescription rates is rather complex and arbitrary. In Europe, prescription analysis consistently showed that most drugs are clearly prescribed to the elderly. In Germany, for example, a thorough analysis utilizing health insurance data found 64% of all drugs were prescribed to patients 60 years and older (Schwabe and Paffrath 2008). Also, individual prescription rates are increasing with advanced age and do not plateau up to age 80 and over. Table 2 summarizes prescription rates for different countries, with information retrieved from population-based studies. These studies are missing for India, and hospital-based data had to be given instead for comparison. Table 3 provides data on functionality, multimorbidity, and polypharmacy. Polypharmacy and multimorbidity prevalences are found to range from 12% to 25% of the elderly.

Functionality, Frailty, and Multimorbidity

Functionality is a significant constituent of well-being and an essential prerequisite for activities

Table 1 General demographic data

	United States	Brazil	India	Germany
Persons 65 and over (percentage of all, estimation 2010) ^a <i>expected 2020 data</i>	40.5 Mio (13.0%) <i>54.7 Mio</i> (16.2%)	13.7 Mio (7.0%) <i>20.3 Mio</i> (9.5%)	60.3 Mio (4.9%) <i>87.5 Mio</i> (6.2%)	16.8 Mio (20.4%) <i>18.6 Mio</i> (23.3%)
Persons 80 and over (percentage of all, estimation 2010) ^a <i>expected 2020 data</i>	11.8 Mio (3.8%) <i>13.0 Mio</i> (3.9%)	2.9 Mio (1.5%) <i>4.4 Mio</i> (2.1%)	8.2 Mio (0.7%) <i>12.6 Mio</i> (0.9%)	4.2 Mio (5.1%) <i>6.0 Mio</i> (7.5%)
Current life expectancy at birth ^b	Women: 81.1 years Men: 76.2 years	Women: 82.1 years Men: 70.7 years	Women: 64.2 years Men: 64.4 years	Women: 18 years Men: 78.2 years
Current remaining life expectancy of 65-year-olds ^b	Women: 20 years Men: 16 years	Women: 18 years Men: 16 years	Women: 15 years Men: 14 years	Women: 20 years Men: 16 years
Current remaining life expectancy of 80-year-olds ^b	Women: 10 years Men: 8 years	Women: 10 years Men: 9 years	Women: 7 years Men: 7 years	Women: 9 years Men: 7 years

Mio: million

^aCurrent data retrieved from the U.N. population estimation database for the year 2010, and the expected data for 2020 under constant fertility scenario given in *italics* (UNPD World Population Prospects 2006)

^bCurrent estimation of the United Nations (UNPD World Population Prospects 2006; 2010–2015 constant fertility scenario for life expectancy at birth, 2000–2005 for life expectancy at given age); data from United Nations (2011)

and participation of the individual. The WHO acknowledges this in its framework of health and disease; functionality is addressed in a separate diagnostic manual that tries to assess this complex issue, the ICF (International Classification of Functioning, Disability and Health; WHO 2001). However, this framework is rather complicated; in daily practice and geriatrics, functionality as defined by self-competence in ADLs (activities of daily living) is assessed according to the ADL/IADL (instrumental activities of daily living) framework. Although rather simple, this framework is still not globally implemented in health surveys. Therefore, population-based data given in Table 3 concern several items and countries. As a common problem with the description and evaluation of complex concepts like functionality, data aggregation into a general index may mask individual and yet significant differences (Gupta 2008). Nevertheless, the general ADL index is widely applied to describe the level of general functionality in the elderly

(Stone et al. 1994; Sato et al. 2002). This index has limitations regarding the decision of whether self-management of pharmacotherapy still is feasible. For example, an individual with an ADL index of 70 of 100 points may still be able to manage medications properly as functional limitations are restricted to locomotion, but another patient with the same score may not be capable if the ADL limitation is mainly based on forgetfulness and low visual acuity.

Vulnerability of older persons is described not only by functional limitations or multimorbidity but also by the presence of the frailty syndrome as described in chapter “Pharmacotherapy and the Frailty Syndrome” in more detail. As the definition of the frailty syndrome by Fried’s criteria (Fried et al. 2001) was published only in the early 2000s, the different aspects of this syndrome, like hand-grip strength or walking speed, are usually not assessed in population-based surveys dating further back, especially not outside Western countries. Nevertheless, to give some

Table 2 Drug prescription in elderly

Drugs	United States (%)	Brazil (%)	India (%) ^a	Germany (%)
Antihypertensives		8.9 ^b		11.3 ^c
Digoxin	9 ^d			31.0 ^c
β-blockers	7 ^d	3.8 ^b		5.5 ^c
ACE inhibitors	7 ^d	12.6 ^e	25.2 ^f	5.3 ^c
Ca antagonists	8 ^d	7.3 ^e	28.3 ^f	22.8 ^c
Oral antidiabetics	3 ^d	6.2 ^e		11.4 ^c
Analgesics	16 ^{d, g}	3.6 ^b		
NSAIDs	10 ^d	4.3 ^b		33.8 ^c
Diuretics	20 ^d	6.4–14.7 ^{b, e}	28.3 ^f	30.4 ^c
Antipsychotics		3.9 ^e		4.4 ^c
Antidepressants	1 ^d			3.3 ^c
Corticosteroids				
Lipid-lowering drugs	15 ^d	2.4 ^e	26.9 ^f	7.5 ^c
Anticoagulants	8 ^d			
Benzodiazepines	2% ^d			12.4 ^{c, h}

NSAIDs nonsteroidal anti-inflammatory drugs

^aNo population-based survey in India concerning this topic; hospital data are given instead

^bPopulation-based survey in an urban region in Brazil (Filhoa et al. 2004)

^cData from Berlin Aging Study (BASE), a population-based survey done between 1990 and 1993 among people 70 years and older people in an urban setting (Baltes and Mayer 2001)

^dPopulation-based survey in the United States including over-the-counter drugs in elderly persons 65 years and older (Kaufman et al. 2002)

^ePopulation-based survey in a defined region in Brazil among individuals 60 years and older (de Loyola Filho et al. 2006)

^fA multicenter hospital survey in India done in 2008 and 2009 (Harugeri et al. 2010)

^gIn this survey, acetaminophen

^hLabeled in the survey as hypnotics

impressions about the prevalence in the older population data from a population-based longitudinal study in the United States, the Cardiovascular Health Study may be cited. In this study, over 5,000 subjects older than 65 years were included. Based on body impedance analysis, prevalence data for the presence of sarcopenia could be retrieved (Janssen et al. 2004). These data revealed that 70.7% of men and 41.9% of women disclosed moderate sarcopenia, which was even severe in 17.2 % of men and 10.7% of women. In another population-based cohort (the New Mexico Elder Health Survey), the DXA (dual energy x-ray absorptiometry) method was applied to detect sarcopenia. Although the methodology differed from that used in the former cohort, prevalence rates for sarcopenia increased with advanced age from 13% to 24% in subjects aged below 70 to over 50% in octogenarians and older (Baumgartner et al. 1998). Applying the Fried criteria, the prevalence of the frailty syndrome was found between 15.5% and 31.3% in persons aged 85 years and over in the Cardiovascular Health

Study cohort. Some subgroups of elderly may disclose even higher prevalence rates. Purser et al. (2006) published 27% prevalence rates for frailty in a group of inpatients 70 years and older with coronary heart disease if assessed by Fried's criteria and exceeding 60% when the presence of any ADL impairment was taken as a criterion.

In Lawton and Brody's score of significant IADLs, "medication management" is listed among a total of eight items (Lawton and Brody 1969). This activity may be subdivided further:

- Recognizing the medication
- Correct dosing
- Managing the handling of the medication package with respect to dosing aid

Several studies clearly disclosed that elderly patients frequently fail to manage the handling of medication packages and correct dosing correctly (Atkin et al. 1994).

In another study by Nikolaus et al. (1996), 143 elderly patients without signs of cognitive decline were thoroughly analyzed concerning their ability to manage standard medication

Table 3 Functionality, multimorbidity, and polypharmacy in the elderly

Functional domain	United States (%)	Brazil (%)	India (%)	Germany (%)
<i>Locomotion</i>				
Unable to use public transportation				31.2 ^a
Unable to take a walk	20.3–30.9 ^b	6.2 ^c	5.6–8.4 ^d	10.6 ^a
Unable to climb stairs	7.0–5.7 ^b			11.4 ^a
Unable to perform bed-chair transfer			1.3–1.7 ^d	2.7 ^a
Uses walking aid	10.9–12.9 ^b			20.9 ^a
Bound to wheelchair				3.1 ^a
Postural stability impaired	18.7–66.0 ^c			44.2 ^a
Difficulty moving around ^f		44.7–63.6 ^g	71.9–84.6 ^g	52.3–75.0 ^g
<i>Self-care</i>				
Unable to take shower/bath		2.0 ^c		16.0 ^a
Unable to go shopping ^h				33.7 ^a
Difficulty in household activities ^f		54.6–63.8 ^g	78.3–85.1 ^g	
Needs help in clothing ^h	8.2–7.5 ^b			5.9 ^a
Needs help in grooming ^h	5.9–7.2 ^b			1.3 ^a
Difficulty in self-care ^f		16.2–39.5 ^g	56.0–76.5 ^g	18.8–45.8 ^g
Needs help to use the toilet ^h				3.2 ^a
Needs help in eating ^h	4.3–5.2 ^b	4.5 ^c		0.9 ^a
<i>Sensorium</i>				
Uses visual aid				95.6 ^a
Visual impairment	8.8–19.2 ⁱ		25.3–27.5 ^j	26.6 ^a
Difficulty with seeing ^f		34.0–59.7 ^g	66.6–61.4 ^g	25.5–37.5 ^g
Uses hearing aid				15.5 ^a
Hearing impaired			15.4–19.5 ^j	18.6 ^a
<i>Cognition</i>				
Impaired cognition	2.7–27.4 ^k	14.9 ^l	9.8–11.0 ^j	14.0 ^a
Difficulty with remembering ^f		58.7–86.0 ^g	70.2–80.3 ^g	29.3–56.2 ^g
<i>Polypharmacy/multimorbidity</i>				
Unable to manage medication ^h				2.6–14.8 ^m
Five or more diagnoses			5.9 ^{j,n}	28.0 ^a
Five or more drugs prescribed	12.0–16.0 ^o	25.2 ^{p,q}		37.5 ^a

^aData from Berlin Aging Study (BASE), a population based survey done between 1990 and 1993 among people 70 years or older in an urban setting (Baltes and Mayer 2001)

^bData from National Health and Nutrition Examination Survey (NHANES) III, a population-based survey in the United States, 1988–1994; data given as men-women (Osthega et al. 2000)

^cData from population-based survey in Brazil. Pesquisa Nacional por Amostra de Domicílios (PNAD) 1998 (Lima-Costa et al. 2003)

^dPopulation survey in India, NSS 60th Round Unit level data 2004; data differ between urban and rural regions (Prasad 2011)

^eSame source as note b; data stratified to age and gender (Osthega et al. 2000)

^fItem used to qualify functionality in the World Health Survey (WHO 2011)

^gData from the World Health Survey 2003; data given for 60- to 80-year-old participants

^hItem listed in activities of daily living/instrumental activities of daily living (ADLs/IADLs) framework

ⁱData from NHANES, a population-based survey in the United States, 1999–2002 (Vitale et al. 2006)

^jPopulation survey in India NSS data 1995–1996; data differ to ethnic groups (Rajan 2007)

^kData from NHANES III, a population-based survey in the United States, 1988–1994; data stratified according to different age groups, 60–85 years (Zhang et al. 2001)

^lSame source as note p (Tamanini et al. 2011)

^mPopulation-based survey. Möglichkeiten und Grenzen einer selbstständigen Lebensführung hilfe- und pflegebedürftiger Menschen in Privathaushalten (MUG) 1990 (Wahl and Wetzler 1998)

ⁿThree or more chronic conditions

^oSame source as note b; data stratified to age 65–74 years and 75 years and over (Centers for Disease Control and Prevention 2011)

^pData from a population-based survey in Sao Paulo. Saúde, Bem-estar e Envelhecimento (SABE) among people 60 years or older (Secoli et al. 2010)

^qIn this cohort, six and more drugs

packages. Of these, 10.1% were unable to open a standard blister package, 44.5% were unable to open a flip top, and 16.8% were unable to open a standard medication container (dosette) as a frequently used predosing aid. These are surprisingly high rates, underlining that medication packages and dosing aids are far from easily manageable by the elderly; this may significantly contribute to dosing errors and treatment failures. To handle such a complex task, unimpaired functionality in at least three domains is required:

- Cognition
- Visual acuity
- Manual dexterity

To test for these three domains simultaneously, Nikolaus et al. (1996) recommended the timed test of money counting, which requires the patient to count a given set of coins and bank notes contained in a closed purse.

The prevalence of cognitive impairment is strongly increasing with advanced age beyond age 75. Table 3 compiles related data from different surveys. In addition, in the Cardiovascular Health Study the prevalence rate was 16% in women and 14% in men aged 75 years or older. Visual acuity may be impaired in the elderly due to a large number of diseases. The most significant ones are cataract, glaucoma, and maculopathy. In a population-based U.K. study, Van der Pols et al. (2000) found prevalence rates for impaired visual acuity up to 46–49%, with the highest rates seen among nursing home residents. However, in a significant portion of these elderly, even simple measures to correct visual acuity (adequate glasses) are not fully applied (Winter et al. 2004). Manual dexterity is less well analyzed in the elderly, and precise prevalence data are lacking. However, an increasing clinical significance in the elderly may be assumed from experimental data (Ranganathan et al. 2001).

Adverse Drug Reactions

Identification and analysis of ADRs utilize data from variable sources, thus creating a rather heterogeneous database. This covers anecdotal reports, monitoring studies, and cohort and

case-control studies. These data are brought together by meta-analyses to recalculate real incidence rates, but this may be flawed by inherent methodological problems. Low-rate, but nevertheless serious, ADRs are often underreported in studies, and the association of symptoms of health-related problems with drug prescription may remain unclear or missed. Even in randomized controlled studies (RCTs) that are well controlled, monitoring of adverse effects and reporting of these is still often incomplete (Ioannidis and Lau 2001). Moreover, cohort studies and RCTs frequently do not represent daily practice (“real world”) due to low external validity and exclusion of significant patient groups (Rothwell 2005). Therefore, pharmacovigilance often reveals serious adverse effects years after market introduction of newly developed drugs, and the risk-benefit ratio may shift significantly. This underlines the value of pharmacovigilance systems. Another problem in this context relates to the correct coding and categorization of the large variety of drugs available. This is especially seen in centrally acting drugs (e.g., neuroleptics), an issue that further flaws detailed analysis and comparison of different data sources. For example, a clear distinction between classic tricyclic antidepressants and modern selective serotonin reuptake inhibitors (SSRIs) is a prerequisite for an adequate evaluation of a proposed differential risk-benefit ratio; unfortunately, this is impossible in the majority of cohorts as differentiation of these drugs is lacking in the data matrix.

These aspects clearly explain the comparably large variance in reported incidence rates of ADRs. For elderly patients, alarmingly high prevalence rates for overall ADRs have been published. In a longitudinal population-based cohort, Schneeweiss et al. (2002) found higher incidence rates of ADRs with increasing age. In patients older than 70 years, 20 events per 10,000 patients were observed, and a U.S. survey among ambulatory elderly patients revealed an overall ADR incidence rate of 50.1 events per 1,000 patient years (Gurwitz et al. 2003). Among the elderly, nursing home residents represent a subgroup that is particularly vulnerable to ADRs,

and the incidence rates even largely exceeded those values mentioned (Monette et al. 1995). Besides incidence rates in hospital-based cohorts, prevalence rates of ADRs during a hospital stay also may be calculated. A recent study from the European GIFA (Gruppo Italiano di Farmacoepidemiologia nell'Anziano) group analyzed data retrieved from such a hospital-based cohort of elderly inpatients. The authors found a 6.5% prevalence rate for ADRs and analyzed predictors of ADRs to build up a risk-scoring tool (Onder et al. 2010). Significant predictors were

- Reduced glomerular filtration rate (<60 ml/min)
- Multimorbidity (four and more comorbid conditions)
- Liver disease
- Five or more drugs prescribed
- Previous ADR

Similar to studies analyzing incidence rates, prevalence rates in hospital-based cohorts also were found to increase with advanced age and reach up to 24% in patients 70 years and older (Manesse et al. 1997). A more recent meta-analysis on this topic, however, found the considerable variability mainly depended on different methodologic approaches, thus confirming the mentioned issues (Kongkaew et al. 2008). Finally, Pirmohamed et al. (2004) performed a detailed analysis of hospital admissions associated with ADRs and found a considerable fraction to be preventable. This points to an unmet need in medical care and discloses a significant quality gap of drug prescribing and monitoring.

Drugs most frequently involved in ADRs are

- Cardiovascular agents
- Antibiotics
- Diuretics
- NSAIDs (nonsteroidal anti-inflammatory drugs)
- Anticoagulants
- Antidiabetics

Frequent symptoms caused by ADRs are

- Gastrointestinal symptoms (e.g., diarrhea, nausea, loss of appetite)
- Electrolyte imbalance
- Impaired renal function
- Bleeding

These lists apply to both younger adults and elderly alike. A few more symptoms have to be added to the list as these are of special significance in the elderly:

- Delirium
- Constipation
- Orthostatic hypotension
- Falls

These clinical problems show an increasing prevalence and incidence with advancing age, and it may be assumed that a considerable contribution to this gain may come from ADRs. Hence, a logical question in relation to these epidemiological results is whether these increasing incidence and prevalence rates are caused by age-related changes and increased vulnerability or just reflect polypharmacy and expanding drug prescriptions. To answer this, Field et al. (2004) performed a nested case-control analysis in a cohort of ambulatory elderly in the United States (New England). They found in 1,299 patients who experienced an ADR and 1,299 control subjects that indeed a significant association between ADR and comorbidity in relation to the number of prescribed drugs existed, but this was not so between ADR and age as such.

More frequent ADRs seen in the elderly not only are consequences of an increased vulnerability but are also significantly caused by polypharmacy and multimorbidity.

Table 3 compiles data on multimorbidity and polypharmacy in the elderly. The BASE investigators (see previous discussion) performed an extensive and individual analysis of prescribed drugs, thereby evaluating not only polypharmacy but also treatment errors due to unindicated drugs and both under- and overtreatment. They found unnecessary drugs prescribed to 13.7% of all persons and inappropriate drugs prescribed to 18.7% (Baltes and Mayer 2001). Among all inappropriate drugs, the most frequent ones were

- Reserpine
- Diazepam
- Amitriptyline
- Indomethacin

References

- Atkin PA, Finnegan TP, Ogle SJ, Shenfield GM (1994) Functional ability of patients to manage medication packaging. A survey of geriatric inpatients. *Age Ageing* 23:113–116
- Baltes PB, Mayer KU (eds) (2001) *The Berlin aging study, aging from 70 to 100*. Cambridge University Press, Cambridge
- Baumgartner RN, Koehler KM, Gallagher D et al (1998) Epidemiology of sarcopenia among the elderly in New Mexico. *Am J Epidemiol* 147:755–763
- Centers for Disease Control and Prevention (2011) National Health and Nutrition Examination Survey (NHANES) III. <http://www.cdc.gov/nchs/data/nhanes/databriefs/preuse.pdf>. Accessed 31 Oct 2011
- de Loyola Filho AI, Uchoa E, Lima-Costa MF (2006) Estudo epidemiológico de base populacional sobre uso de medicamentos entre idosos na Região Metropolitana de Belo Horizonte, Minas Gerais, Brasil. *Cad Saúde Pública Rio de Janeiro* 22:2657–2667
- de Winter LJM, Hoyng CB, Froeling PGAM, Meulendijks CFM, van der Wilt GJ (2004) Prevalence of remediable disability due to low vision among institutionalized elderly people. *Gerontology* 50:96–101
- Field TS, Gurwitz JH, Harrold LR et al (2004) Risk factors for adverse drug events among older adults in the ambulatory setting. *J Am Geriatr Soc* 52:1349–1354
- Filho JMC, Marcopitob LF, Castelob A (2004) Perfil de utilização de medicamentos por idosos em área urbana do Nordeste do Brasil. *Rev Saude Publica* 38:557–564
- Fried LP, Tangen CM, Walston J, Cardiovascular Health Study Collaborative Research Group et al (2001) Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci* 56:M146–M156
- Gupta A (2008) *Measurement scales used in elderly care*. Radcliffe, Oxford
- Gurwitz JH, Field TS, Harrold LR et al (2003) Incidence and preventability of adverse drug events among older persons in the ambulatory setting. *JAMA* 289:1107–1116
- Harugeri A, Joseph J, Parthasarathi G, Ramesh M, Guido S (2010) Prescribing patterns and predictors of high-level polypharmacy in the elderly population: a prospective surveillance study from two teaching hospitals in India. *Am J Geriatr Pharmacother* 8:271–280
- Ioannidis JP, Lau J (2001) Completeness of safety reporting in randomized trials: an evaluation of 7 medical areas. *JAMA* 285:437–443
- Janssen I, Baumgartner RN, Ross R, Rosenberg IH, Roubenoff R (2004) Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. *Am J Epidemiol* 159:413–421
- Kaufman DW, Kelly JP, Rosenberg L, Anderson TE, Mitchell AA (2002) Recent patterns of medication use in the ambulatory adult population of the United States: the Slone survey. *JAMA* 287:337–344
- Kongkaew C, Noyce PR, Ashcroft DM (2008) Hospital admissions associated with adverse drug reactions: a systematic review of prospective observational studies. *Ann Pharmacother* 42:1017–1025
- Lawton MP, Brody EM (1969) Assessment of older people: selfmaintaining and instrumental activities of daily living. *Gerontologist* 9:179–186
- Lima-Costa MF, Barreto SM, Giatti L (2003) Condições de saúde, capacidade funcional, uso de serviços de saúde e gastos com medicamentos da população idosa brasileira: um estudo descritivo baseado na Pesquisa Nacional por Amostra de Domicílios. *Cad Saúde Pública Rio de Janeiro* 19:735–743
- Manesse CK, Derkx FHM, de Ridder MAJ, Man in't Veld AJ, van der Cammen TJM (1997) Adverse drug reactions in elderly patients as contributing factor for hospital admission: cross sectional survey. *BMJ* 315:1057–1058
- Monette J, Gurwitz JH, Avorn J (1995) Epidemiology of adverse drug events in the nursing home setting. *Drugs Aging* 7:203–211
- Nikolaus T, Kruse W, Bach M, Specht-Leible N, Oster P, Schlierf G (1996) Elderly patients' problems with medication. An in-hospital and follow-up study. *Eur J Clin Pharmacol* 49:255–259
- Onder G, Petrovic M, Tangiisuran B et al (2010) Development and validation of a score to assess risk of adverse drug reactions among in-hospital patients 65 years or older: the GerontoNet ADR risk score. *Arch Intern Med* 170:1142–1148
- Ostchega Y, Harris TB, Hirsch R, Parsons VL, Kington R (2000) The prevalence of functional limitations and disability in older persons in the US: data from the National Health and Nutrition Examination Survey III. *J Am Geriatr Soc* 48:1132–1135
- Pirmohamed M, James S, Meakin S et al (2004) Adverse drug reactions as cause of admission to hospital: prospective analysis of 18.820 patients. *BMJ* 329:15–19
- Prasad S (2011) *Ailing and hospitalization in India—an analysis of NSS 52nd and 60th round*. Vdm Verlag Dr. Müller Aktiengesellschaft, Saarbrücken
- Purser JL, Kuchibhatla MN, Fillenbaum GG, Harding T, Peterson ED, Alexander KP (2006) Identifying frailty in hospitalized older adults with significant coronary artery disease. *J Am Geriatr Soc* 54:1674–1681
- Rajan IS (2007) *Population aging, health and social security in India*. Center for Development Studies India. CREI, Osaka. http://www.econ.osaka-cu.ac.jp/CREI/discussion/2006/CREI_DP003.pdf. Accessed 15 Oct 2011
- Ranganathan VK, Siemonow V, Sahgal V, Yue GH (2001) Effects of aging on hand function. *J Am Geriatr Soc* 49:1478–1484
- Rothwell PM (2005) External validity of randomized controlled trials: to whom do the results of this trial apply? *Lancet* 365:82–93
- Sato S, Demura S, Minami M, Kasuga K (2002) Longitudinal assessment of ADL ability of partially dependent elderly people: examining the utility of the index and characteristics of longitudinal change in ADL ability. *J Physiol Anthropol Appl Human Sci* 21:179–187
- Schneeweiss S, Hasford J, Gottler M, Hoffmann A, Riethling AK, Avorn J (2002) Admissions by adverse drug events to internal medicine and emergency departments in hospitals: a longitudinal population-based study. *Eur J Clin Pharmacol* 58:285–291

- Schwabe U, Paffrath D (eds) (2008) *Arzneiverordnungs-report*. Springer, Berlin
- Secoli SR, Figueras A, Lebra ML, de Lima FD, Ferreira Santos JL (2010) Risk of potential drug-drug interactions among Brazilian elderly. *Drugs Aging* 27:759–770
- Stone SP, Ali B, Auberleek I, Thompsell A, Young A (1994) The Barthel index in clinical practice: use on a rehabilitation ward for elderly people. *J R Coll Physicians Lond* 28:419–423
- Tamanini JTN, Santos JLF, Lebrao ML, Duarte YAO, Laurenti R (2011) Association between urinary incontinence in elderly patients and caregiver burden in the city of Sao Paulo/Brazil: health, wellbeing, and ageing study. *Neurourol Urodyn* 30:1281–1285
- United Nations, Department of Economic and Social Affairs, Population Division (2011) *World population prospects: the 2010 revision*, New York (comprehensive excel tables). <http://data.un.org>. Accessed 15 Oct 2011
- Van der Pols JC, Bates CJ, Thompson JR, Reacher M, Prentice A, Finch S (2000) Visual acuity measurements in a national sample of British elderly people. *Br J Ophthalmol* 84:165–170
- Vitale S, Cotch MF, Sperduto RD (2006) Prevalence of visual impairment in the United States. *JAMA* 295:2158–2163
- Wahl HW, Wetzler R (1998) *Möglichkeiten und Grenzen selbständiger Lebensführung in Privathaushalten. Integrierter Bericht zum gleichnamigen Forschungsverbundprojekt*. Kohlhammer, Stuttgart
- World Health Organization (2001) *International classification of functioning, disability and health*, Genf. <http://www.who.int/classifications/icf/en/>. Last accessed 25 Oct 2011
- World Health Organization (2011) *Definition of an older or elderly person*. <http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html>. Accessed 13 Dec 2011
- World Health Survey (2011) <http://www.who.int/healthinfo/survey/en/>. Accessed 15 Oct 2011
- Zhang Y, Seshadri S, Ellison RC, Heeren T, Felson DT (2001) Bone mineral density and verbal memory impairment: third National Health and Nutrition Examination Survey. *Am J Epidemiol* 154:795–802

Drug Therapy for the Elderly

Wehling, M. (Ed.)

2013, XV, 356 p. 53 illus., 35 illus. in color., Softcover

ISBN: 978-3-7091-0911-3