

ELECTROLYTE IMBALANCES IN NURSING HOME RESIDENTS: A REVIEW OF PREVALENCE, MANAGEMENT AND CONSIDERATIONS

L. PICKENHAN¹, C. RUNGG¹, N. SCHIEFERMEIER-MACH¹

1. FH Gesundheit, Department of Healthcare and Nursing, Innsbruck, Austria. Corresponding author: Dr. Natalia Schiefermeier-Mach, Deputy Scientific Director, PI, FH Gesundheit, Innrain 98, A-6020 Innsbruck, Austria, Tel. +43 512 5322 75482, Fax +43 512 5322 75200, natalia.schiefermeier-mach@fhg-tirol.ac.at

Abstract: *Background:* Electrolyte imbalances strongly impact on morbidity and mortality rate in elderly adults. In particular, residents of long-term care facilities may develop life-threatening conditions as a result of altered serum electrolyte concentration. European nursing homes have restricted availability of general practitioner, therefore the role of nurses in medical care, prevention practices, early symptoms identification and communication with physicians is indispensable. Many of the risk factors associated with electrolyte imbalances are modifiable or preventable and have to be adequately recognized and managed by health professionals in nursing home settings. *Objective:* The aim of this review is to discuss prevalence and management of electrolyte imbalances in long-term care facilities with focus on nursing homes. *Design:* Narrative literature review. *Methods:* Search was performed in MEDLINE/PubMed and CINAHL databases. Key search terms associated with electrolyte imbalances including hyper- and hypo-states of sodium, potassium and magnesium were utilized in the subject search in combination with nursing homes, long-term care and older adults. *Results and Conclusions:* Published research studies reported higher prevalence of electrolyte imbalances and related mortality rate in nursing home residents when compared to older community adults. Serum sodium imbalances, hyponatremia and hypernatremia, were the most commonly identified. High incidence was also documented for hypomagnesemia and associated hypokalemia. Risk factors strongly associated with electrolyte imbalances included nursing home resident's dietary/ hydration status, presence of comorbidities and type of prescribed medications. In this review we also summarise early signs of electrolyte imbalances and assessments that can be performed locally by nursing personnel. Strengthening awareness for electrolyte imbalances is an important quality-improvement effort from the perspective of nursing home residents and their families that might lower unnecessary hospital transfers, EI complication rates and residents' mortality.

Key words: Nursing homes, fluid and electrolyte balance, long-term care.

Introduction

The European population aged 65 years and older has grown from 10% in 1960 to 19% in 2015 and is expected to further increase (1). This remarkable rise is predicted to be a significant driver for the expansion for long-term care (LTC) and care in nursing homes (NHs). According to European Health Information Gateway, numbers of nursing and elderly home beds in EU account for more than 3 million with the highest numbers in Germany (902.882 beds) and in France (642.168 beds) (2). NH residents are often in a weak health condition, have multiple co-morbidities and strong cognitive impairments and therefore are repeatedly admitted into the hospital (3). Higher incidence of acute hospital admissions among NH residents versus community dwellers has been reported (4). However, a systematic review by Arendts and Howard (5) showed that 40% of NH residents after being transferred to an emergency department were sent back to the NH without admission to hospital. Other published data on avoidable hospital admissions varies from 1.6% to 77% in different countries and settings (6), an Austrian study performed in 2015, reported a 22% rate of avoidable NH-to-hospital transfers (7, 8). Fluid and electrolyte imbalances (EI) are among health conditions that can be often prevented and to some extent managed locally at the NH. It has been previously

acknowledged that prevention of electrolyte disorders in LTC facilities decreases unnecessary rehospitalisation rates (9–11).

In NHs, prevention of electrolyte imbalances goes hand in hand with prevention of other nonspecific complications such as malnutrition, dehydration, depression, cognitive decline or falls. However, there exist important nursing considerations that are explicit to the EI management. The aim of this review is to discuss the EI specificities, prevention, monitoring and perspectives in long-term care facilities with focus on NHs.

Specificities of Electrolyte Imbalances in Nursing Home Residents

Prevalence

Fluid and electrolyte imbalances have strong impact on morbidity and mortality rates in older adults. Hypo- as well as hyper states of sodium and potassium are often forms of EI, whereas other electrolyte disorders are less abundant (12, 13). Older people with diagnosed EI repeatedly attend the emergency department, exhibit increased hospitalization and a higher admission rate to NHs (14–17).

Decreased serum sodium, hyponatremia, is the most common EI in hospitalized patients (18) that is associated with high morbidity and mortality (19) and is particularly frequent in the institutionalized older adults (15). Choudhury and

co-authors examined NH and older community residents with diagnosed hyponatremia during hospitalization and analyzed risk factors for adverse outcome of this EI. It was found that NH residents were 43-fold more likely to be hospitalized with hyponatremia ($\text{Na} < 135 \text{ mmol/L}$) and 16-fold more likely to be admitted with serum $\text{Na} < 125 \text{ mmol/L}$ than older community patients (14). Miller et al. reported 18% prevalence of hyponatremia among NH residents, whereas solely a prevalence of 8% was recorded in the age-matched ambulant population. The incidence in this study for hyponatremia in NH residents was detected with 53% (20).

Hypernatremia ($\text{Na} > 145 \text{ mmol/L}$) is another common EI associated with a high mortality rate (21, 22). In most cases increased serum sodium reflects total body water loss (23–25). In NH residents, hypernatremia is considered avoidable as it goes hand in hand with the prevention of dehydration. Despite this, dehydration was shown as a common reason of admission to hospital in NH residents (26, 27). Wolff et al. collected data from 21,610 emergency patients older than 65 years and determined a 10-fold higher prevalence of hypernatremia ($\text{Na} > 145 \text{ mmol/L}$) in patients admitted from NHs compared to those living at their private homes. These NH patients were dehydrated at admission to the hospital and, as a result, appear to be at a significantly greater risk of in-hospital mortality (28).

High serum potassium, hyperkalemia ($\text{K} > 5.0 \text{ mmol/L}$), is a life-threatening electrolyte disorder that can lead to arrhythmias and sudden cardiopulmonary arrest (29). Previous studies in older adults with chronic kidney disease showed up to 50% incidence of hyperkalemia (30). However, no prevalence of hyperkalemia was directly acquired in NH residents so far and this disorder is mainly discussed in association with chronic kidney impairment and RAAS-targeting medications (renin-angiotensin-aldosterone system) (31). Hypokalemia ($\text{K} < 3.5 \text{ mmol/L}$) is occasionally seen in elderly patients and is often attributed to decreased potassium intake, loss through the gastrointestinal tract or urinary loss as a side effect of diuretic medication (21, 32, 33).

Hypokalemia is often associated with hypomagnesemia and hypocalcemia (34). Hypomagnesemia ($\text{Mg} < 0.66 \text{ mmol/L}$) does not lead to clinically important symptoms until serum levels fall below 0.5 mmol/L . Life-threatening complications of hypomagnesemia arise when associated with hypostates of other electrolytes, such as calcium, phosphorus and potassium (35). The hypomagnesemia was found in 36% of the LTC patients; and amongst them 18% had severe hypomagnesemia (36). The same study found strong association between hypomagnesemia, hypokalemia, hypophosphatemia and hypokalemia and also increased mortality rates in EI-affected residents (36).

Dietary and hydration status

Dehydration and malnutrition were often reported in older adults (24, 37). Thirst response, taste sensation, appetite and food consumption decline with increasing age. Older people

are less hungry, consume a smaller amount of meals, eat more slowly, have fewer snacks between meals and become satiated more rapidly after meals. NH residents may not like the offered food due to visual appearance, lack of variety or the inability to address individual food preferences (13). It was suggested that also social factors and psychological stress contribute to malnutrition and decreased fluid intake (38).

Dehydration is acknowledged as a frequently occurring issue among NH residents (39). Dehydration was also reported as one of the most common reasons for emergency hospitalization of NH residents (40). Impairments of mental health, such as dementia, can also affect the sense of thirst resulting in an insufficient liquid supply. A further contributing factor is the immobility to independently gain access to drinks (24). Even with adequate drinking, fluid volume deficits may result from polyuria related to chronic diseases like kidney failure or diabetes (41). Additionally to the abovementioned factors, NH residents may fail to obtain enough liquids as they are depended on water supply and the support in drinking by nursing personnel (28, 42). Contributing psychological factors like a new living situation or shame and fear to express intimate needs may lead to dehydration (40). Several excellent reviews describe the essential importance of drinking and eating especially for older adults and NH residents and thus addressing the complex and challenging matter for nurses to ensure the aforementioned (38, 43).

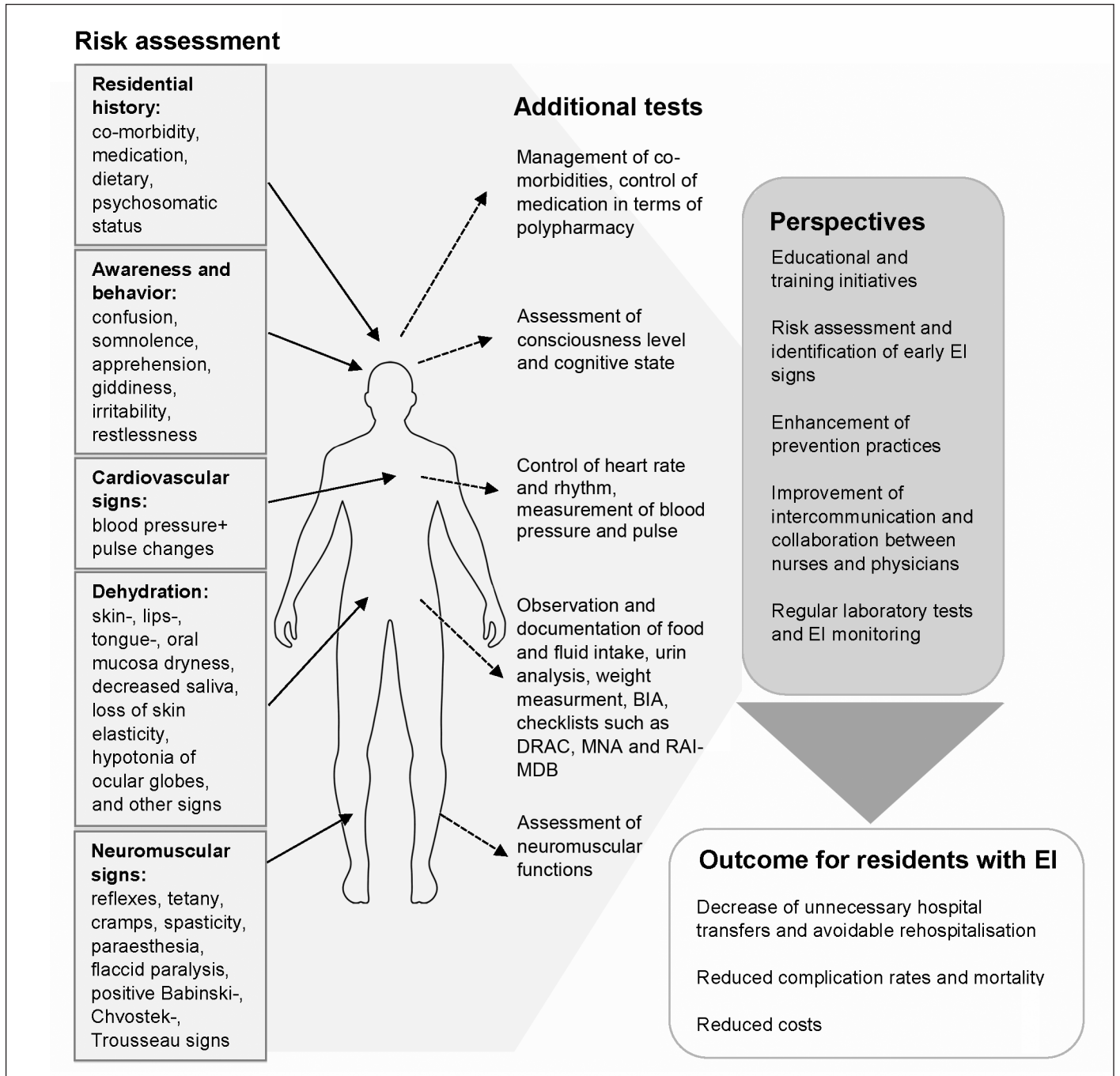
Multimorbidity

The prevalence of multimorbidity in NH residents was shown to reach up to 82% (44). The presence of multimorbidity strongly increases the risk to develop EI (45, 46). Clearly, acute and chronic kidney diseases lead to imbalances of all body electrolytes (24, 47). Diabetes mellitus was shown to be associated with hyponatremia and hypomagnesemia (48). Both hypertension and hypotension are strong risk factors for development of EIs. Chronic hypertension was identified as a significant risk factor for hypokalemia and hyponatremia (47, 48). Hypertension itself may also be not a cause, albeit a consequence of hypernatremia, hypercalcemia and hypomagnesaemia (49). The syndrome of inadequate antidiuretic hormone secretion is strongly associated with hyponatremia in the older population (24). Serious hypernatremia and hypomagnesemia may also be a result of an increased loss of water in course of acute infections, emesis or diarrhea (50). Among other important factors, swallowing difficulty (dysphagia), dental problems, alcohol abuse, impaired mental cognition (for example dementia), should alert nurses as these conditions are associated with an increased risk of developing EIs and dehydration (51). Another recurrent problem, urine and bowel incontinence, is a common condition in NH residents and a significant health problem. The prevalence of incontinence worldwide is ranging from 3% to 17% with a high rate of unrecorded cases (52). Frequently going to the toilet, particularly at night, can result

DO PHYSICAL FUNCTION IN NURSING HOME RESIDENTS CHANGE DURING THEIR STAY?

Figure 1

Prevention and early detection of electrolyte imbalances. Risk assessment categories, additional tests currently available at NH, perspectives and outcome of EI management are illustrated



EI - electrolyte imbalance, NH - nursing home, BIA - bioelectrical impedance analysis, DRAC – Dehydration Risk Appraisal Checklist, MNA - Mini Nutritional Assessment, RAI-MDB - Resident Assessment Instrument RAI-MDB

ELECTROLYTE IMBALANCES IN NURSING HOMES

in a heavy burden for older NH residents. Feelings of shame or anxiety can lead, consciously or unconsciously, to little or no drinking in order to reduce incontinence and toilet use. As a consequence this may lead to dehydration and sodium imbalance (16, 38).

Polypharmacy

NH residents with chronic diseases receive multiple medications. It was shown that more than 70% of NH residents from eight European countries obtain five or more medications regularly (53). Many medications commonly used in NHs may cause strong EIs: diuretic drugs, medicaments against cardiovascular diseases, analgesics, non-steroidal anti-inflammatory drugs, laxatives and antidepressants were shown to cause EIs (48, 54). It was revealed that administration of psychotropic drugs (phenothiazines, butyrophenones, benzodiazepines, tricyclics, serotonin-reuptake inhibitors), anti-epileptic drugs (carbamazepine, oxcarbazepine), anti-cancer drugs (prostaglandin-synthesis inhibitors, cyclophosphamide), opiate derivatives, thiazide diuretics and desmopressin are associated with hyponatremia, whereas lithium, vasopressin V2 receptor antagonists, loop diuretics and mannitol may induce hypernatremia (55). Thiazide and loop diuretics were also linked to hypokalemia as well as hypomagnesemia (48). Medications to treat hypertension (angiotensin converting enzyme inhibitors, renin inhibitors, angiotensin receptor blockers), heparin and nonsteroidal anti-inflammatory drugs were shown to interfere with urinary excretion of potassium (55).

Management of Electrolyte Imbalances in Nursing Homes

In many European countries, NHs are not required to employ GP and are not equipped with diagnostic and therapeutic resources (7, 8, 56). In Norway for instance, roles or duties of physician in NH are not specified in legal protocols and they are not obliged to provide medical service at all times (57). In Germany and Austria, NH residents can choose their physician freely but the availability of GP is often limited (8, 57, 58). Only 25% of German NHs were reported to have a contract with GP and accessibility of physician outside working hours is not organized (57). Thus, nursing personnel is solely responsible for residents' care, prevention practices, early symptoms identification and communication with physician. Current EI management and perspectives in the NH setting are summarized in Figure 1 and discussed below.

Initial Management

A new admission into a NH is the essential moment to review and document resident's medical history. In case of unclear documentation and/or cognitive impairment of residents, it is important to contact the family and GP. Medical history records have to include questions about chronic diseases, injuries, use and dosage of specific medication received up to the day of NH admission. In some cases existing

prescription of medication might be reconsidered to decrease strong side effects and optimize the NH resident's quality of life (59). Thorough analysis of NH resident medical history and protocol of current health status will not only support the estimation of a given risk for EI, but also in many cases help nurses to prevent potential future problems.

In clinical practice, it is recommended to regularly monitor serum electrolytes in diseased and older adults. Laboratory tests are performed in hospital settings or are prescribed by GP. However, diagnostic options, medical care and availability of GP at NHs vary among different countries and even within one county. Therefore, it should be recommended to perform blood/urine biochemical testing short after NH admission and also plan future monitoring schedules.

Monitoring and Prevention Practices

Regular practices should be applied locally in the NH settings in order to avoid unnecessary stress of hospital transfer. Moreover, NH nurses cannot rely on one-time procedure/test, but instead they should have the possibility to perform electrolyte EI checks at a regular basis in order to monitor changes. Thus, compared to hospital settings, the system of EI management in NHs may be absent or not clearly stated.

Nursing considerations in EI management include recognition of multiple factors, in case of noticed abnormalities interaction with/report to GP is obligatory:

- Assessment of hydration and nutrition status
dehydration and malnutrition can be prevented and to some extent improved by nursing staff, assessment and monitoring can be performed in NH
assessment includes monitoring of food and fluid intake/output, body weight measurements, checking vital signs as well as skin, mouth and eye assessments, blood pressure and pulse rate, capillary and foot vein refill, and analysis of urine colour and volume (43);
hydration status can be also assessed by bioelectrical impedance analysis (BIA) and checklists /assessment tools such as Dehydration Risk Appraisal Checklist (DRAC) (60), The Mini Nutritional Assessment (MNA) (61) or as a part of more general assessment tools, for instance Resident Assessment Instrument RAI-MDB (62)
assessment can be performed monthly/weekly or more often according to the GP prescription for the high risk residents;
- Clinical signs and symptoms of dehydration
checking of dehydration clinical signs and symptoms can be performed in NH (see above); clinical signs include dryness of tongue, oral mucosa and/or lips, decreased saliva, dryness of skin and loss of elasticity, hypotonia of ocular globes, changes in urine including low volume, dark colour, increased pulse rate, low blood pressure, increasing confusion, lethargy, agitation or headache.

- Monitoring of kidney function
additional to weight/fluid monitoring, renal function laboratory values should be checked annually, interaction with GP is required for monitoring schedules and prescription
- Cardiovascular symptoms
blood pressure, pulse and heart rhythm measurements can be performed in NH
- Vital signs and neurological assessment
regular monitoring of vital signs can be performed in NH, nurses should be educated also about neurological signs of EIs and encouraged to check recurrently for warning signs

Education and Training

Since the capacity of NHs to manage EIs can be limited due to the absence of diagnostic equipment and lack of GP professional input, the role of nurses becomes indispensable (7,8,56). Nurses are often responsible for the decision-making of resident transfer to hospital. Previous studies showed that registered nurses (RNs) and to some extent assistant nurses (ANs) possess a high degree of self-responsibility in ensuring NH medical care and hospital transfer (63).

Insufficient geriatric knowledge of nurses results in difficulties in early sign interpretation and delays in symptom recognition. A critical review of nursing staff education showed a strong need to improve training in NH settings (64, 65). It has been documented that the professional knowledge of fluid and electrolyte balance amongst nurses is insufficient (66, 67). There is a major gap in the way EIs are managed (68) and nursing staff fail to appreciate the susceptibility of NH residents with electrolyte abnormalities to poor health outcomes (69). Our preliminary data from a survey performed among Austrian NH staff (RNs and ANs) revealed that 86% of nurses described their knowledge about body electrolytes as “insufficient” and 93% of participants have high interest in further professional training to this topic (our unpublished data).

Under these circumstances, prevention and early detection become crucial. As long as there is no legal obligation to organize regular presence of physician, more emphasis should be given on educational initiatives for NH nurses. Training courses should include information and advice relating the risk factors for EIs, drinking and dietary principles as well as possible complications. Nurses also need decision-support tools, strong interprofessional communication skills and possibility to contact GP at any time. Residents with re-occurring EI or recognized high risk to develop the latter should undergo regular assessments, which are preferably performed within the NH. Availability of point-of-care testing could provide a good opportunity for consistent electrolyte monitoring. Consequently, revision of the dietary plan and drinking protocols should be addressed. It is important not only to monitor for symptomatic improvement or signs of

deterioration but also to track the rate of correction. It may also be suggested to establish robust outcome measures to assess the EI management within NH including hospital transfer rates, complication rates, residents’ mortality and costs calculation.

Conclusions and Perspectives

Older residents of NH are at high risk to develop EIs. Compared to hospital settings, EI prevention and management in NH is the responsibility of nursing personal. Regular assessments performed locally in NH, additional educational and training initiatives for nursing personnel and improved interprofessional communication are strongly suggested to ensure good quality of long-term care in NH settings.

Methods, Data Sources: Search was performed in MEDLINE/PubMed and CINAHL databases. Key search terms associated with electrolyte imbalances including hyper- and hypo-states of sodium, potassium and magnesium were utilized in the subject search in combination with nursing homes, long-term care and older adults. The full texts of research papers were reviewed prior to their inclusion according to the Strobe guidelines.

Conflict of Interest Disclosure: All participating authors declare no conflict of interest

Acknowledgment: We want to thank Dr. Sandra Schaffenrath for writing assistance, language editing, and proofreading of the manuscript.

References

1. World Health Organization (WHO). European Health Information Gateway: % of population aged 65+ years [Internet]. 2015 [updated 2019 Oct 8]. Available from: https://gateway.euro.who.int/en/indicators/hfa_13-0030-of-population-aged-65plus-years/visualizations/#id=18816&tab=table
2. World Health Organization (WHO). European Health Information Gateway: Numbers of nursing and elderly home beds [Internet]. 2015 [updated 2019 Oct 1]. Available from: <https://gateway.euro.who.int/en/hfa-explorer/#fDgBcquLk>
3. Grabowski DC, O’Malley AJ, Barhydt NR. The costs and potential savings associated with nursing home hospitalizations. *Health Aff (Millwood)*. 2007;26(6):1753–61. doi:10.1377/hlthaff.26.6.1753
4. Graverholt B, Riise T, Jamtvedt G, Ranhoff AH, Krüger K, Nortvedt MW. Acute hospital admissions among nursing home residents: a population-based observational study. *BMC Health Serv Res*. 2011;11:126. doi:10.1186/1472-6963-11-126
5. Arendts G, Howard K. The interface between residential aged care and the emergency department: a systematic review. *Age Ageing*. 2010;39(3):306–12. doi:10.1093/ageing/afq008
6. Renom-Guiteras A, Uhrenfeldt L, Meyer G, Mann E. Assessment tools for determining appropriateness of admission to acute care of persons transferred from long-term care facilities: a systematic review. *BMC Geriatr*. 2014;14:80. doi:10.1186/1471-2318-14-80
7. Kada O, et al. Vom pflegeheim ins krankenhaus und wieder zurück... Eine multimethodale analyse von krankenhaustransporten aus alten- und pflegeheimen [From the nursing home to hospital and back again... A mixed methods study on hospital transfers from nursing homes]. *Z Evid Fortbild Qual Gesundhwes*. 2011;105(10):714–22. ger. doi:10.1016/j.zefq.2011.03.023
8. Kada O, Janig H, Likar R, Cernic K, Pinter G. Reducing Avoidable Hospital Transfers From Nursing Homes in Austria: Project Outline and Baseline Results. *Gerontol Geriatr Med*. 2017;32333721417696671. doi:10.1177/2333721417696671
9. Kramer A, Eilertsen T, Goodrich G, Min S-j. Understanding Temporal Changes in and Factors Associated with SNF Rates of Community Discharge and Rehospitalization. Washington, DC: Medicare Payment Advisory Commission [Internet]. 2007 [cited Mai 14, 2019];(E4016381):1–47. Available from: http://67.59.137.244/documents/Jun07_SNF_contractor_CC.pdf
10. Intrator O, Zinn J, Mor V. Nursing home characteristics and potentially preventable hospitalizations of long-stay residents. *J Am Geriatr Soc*. 2004;52(10):1730–6. doi:10.1111/j.1532-5415.2004.52469.x
11. Saliba D, et al. Appropriateness of the decision to transfer nursing facility residents to the hospital. *J Am Geriatr Soc*. 2000;48(2):154–63.
12. Balci AK, et al. General characteristics of patients with electrolyte imbalance admitted to emergency department. *World J Emerg Med*. 2013;4(2):113–6. doi:10.5847/wjem.j.1920-8642.2013.02.005
13. Xing XS, Yamaguchi DT, Weintraub NT. A synopsis of phosphate disorders in the nursing home. *Journal of the American Medical Directors Association*.

ELECTROLYTE IMBALANCES IN NURSING HOMES

- 2010;11(7):468–74. doi:10.1016/j.jamda.2009.10.007
14. Choudhury N, Aparanji K, Norkus EP, Dharmarajan TS. Hyponatremia in hospitalized nursing home residents and outcome: minimize hospitalization and keep the stay short! *Journal of the American Medical Directors Association*. 2012;13(1):e8–9. doi:10.1016/j.jamda.2011.08.010
 15. Upadhyay A, Jaber BL, Madias NE. Incidence and prevalence of hyponatremia. *Am J Med*. 2006;119(7 Suppl 1):S30–5. doi:10.1016/j.amjmed.2006.05.005
 16. Shah MK, Workneh B, Taffet GE. Hyponatremia in the geriatric population. *Clin Interv Aging*. 2014;9:1987–92. doi:10.2147/CIA.S65214
 17. Soiza RL, Cumming K, Clarke JM, Wood KM, Myint PK. Hyponatremia: Special Considerations in Older Patients. *J Clin Med*. 2014;3(3):944–58. doi:10.3390/jcm3030944
 18. Spasovski G, et al. Clinical practice guideline on diagnosis and treatment of hyponatraemia. *Eur J Endocrinol*. 2014;170(3):G1–47. doi:10.1530/EJE-13-1020
 19. Wald R, Jaber BL, Price LL, Upadhyay A, Madias NE. Impact of hospital-associated hyponatremia on selected outcomes. *Arch Intern Med*. 2010;170(3):294–302. doi:10.1001/archinternmed.2009.513
 20. Miller M, Morley JE, Rubenstein LZ. Hyponatremia in a nursing home population. *J Am Geriatr Soc*. 1995;43(12):1410–3.
 21. Reddi AS. Fluid, Electrolyte and Acid-Base Disorders: Clinical Evaluation and Management. 2nd ed. Cham: Springer International Publishing; Imprint; Springer; 2018. 506 p.
 22. Adrogué HJ, Madias NE. Hyponatremia. *N Engl J Med*. 2000;342(20):1493–9. doi:10.1056/NEJM200005183422006
 23. Grundmann F. Elektrolytveränderungen im Alter mit Fokus auf Hyponatriämie [Electrolyte disturbances in geriatric patients with focus on hyponatremia]. *Z Gerontol Geriatr*. 2016;49(6):477–82. ger. doi:10.1007/s00391-016-1117-y
 24. Koch CA, Fulop T. Clinical aspects of changes in water and sodium homeostasis in the elderly. *Rev Endocr Metab Disord*. 2017;18(1):49–66. doi:10.1007/s1154-017-9420-5
 25. Schub T, Parks-Chapman J. Hyponatremia: Quick Lesson. *Nursing Practice Council. Cinahl Information System*. 2018. doi:10.1007/s12028-014-0067-8
 26. Schols, J M G A, De Groot, C P G M, van der Cammen, T J J, Olde Rikkert, M G M. Preventing and treating dehydration in the elderly during periods of illness and warm weather. *J Nutr Health Aging*. 2009;13(2):150–7.
 27. Begum MN, Johnson CS. A review of the literature on dehydration in the institutionalized elderly. *e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism*. 2010;5(1):e47–e53. doi:10.1016/j.eclnm.2009.10.007
 28. Wolff A, Stuckler D, McKee M. Are patients admitted to hospitals from care homes dehydrated? A retrospective analysis of hypernatraemia and in-hospital mortality. *J R Soc Med*. 2015;108(7):259–65. doi:10.1177/0141076814566260
 29. Montford JR, Linas S. How Dangerous Is Hyperkalemia? *J Am Soc Nephrol*. 2017;28(11):3155–65. doi:10.1681/ASN.2016121344
 30. Lazich I, Bakris GL. Prediction and management of hyperkalemia across the spectrum of chronic kidney disease. *Semin Nephrol*. 2014;34(3):333–9. doi:10.1016/j.semnephrol.2014.04.008
 31. Kumar R, Kanev L, Woods SD, Brenner M, Smith B. Managing hyperkalemia in high-risk patients in long-term care. *Am J Manag Care*. 2017;23(2 Suppl):S27–S36.
 32. Bardak S, et al. Community-acquired hypokalemia in elderly patients: related factors and clinical outcomes. *Int Urol Nephrol*. 2017;49(3):483–9. doi:10.1007/s11255-016-1489-3
 33. Lindner G, Pfortmüller CA, Leichtle AB, Fiedler GM, Exadaktylos AK. Age-related variety in electrolyte levels and prevalence of dysnatremias and dyskalemias in patients presenting to the emergency department. *Gerontology*. 2014;60(5):420–3. doi:10.1159/000360134
 34. Kardalas E, Paschou SA, Anagnostis P, Muscogiuri G, Siasos G, Vryonidou A. Hypokalemia: a clinical update. *Endocr Connect*. 2018;7(4):R135–R146. doi:10.1530/EC-18-10109
 35. Pham P-CT, Pham P-AT, Pham SV, Pham P-TT, Pham P-MT, Pham P-TT. Hypomagnesemia: a clinical perspective. *Int J Nephrol Renovasc Dis*. 2014;7:219–30. doi:10.2147/IJNRD.S42054
 36. Arinzo Z, Peisakh A, Schrire S, Berner YN. Prevalence of hypomagnesemia (HM) in a geriatric long-term care (LTC) setting. *Arch Gerontol Geriatr*. 2010;51(1):36–40. doi:10.1016/j.archger.2009.07.002
 37. Godfrey H, Cloete J, Dymond E, Long A. An exploration of the hydration care of older people: a qualitative study. *Int J Nurs Stud*. 2012;49(10):1200–11. doi:10.1016/j.ijnurstu.2012.04.009
 38. Campbell N. Dehydration: best practice in the care home. *Nursing and Residential Care*. 2012;14(1):21–5. doi:10.12968/nrec.2012.14.1.21
 39. Paulis SJC, Everink IHJ, Halfens RJG, Lohrmann C, Schols JMGA. Prevalence and Risk Factors of Dehydration Among Nursing Home Residents: A Systematic Review. *Journal of the American Medical Directors Association*. 2018;19(8):646–57. doi:10.1016/j.jamda.2018.05.009
 40. Bartholomeyczik S, et al. Expertenstandard Ernährungsmanagement zur Sicherung und Förderung der oralen Ernährung in der Pflege. 1st ed. Deutsches Netzwerk für Qualitätsentwicklung in der Pflege, editor. Osnabrück: Hochschule Osnabrück Fakultät für Wirtschafts- und Sozialwissenschaften; Januar 2017. 128 p. ger.
 41. Martin P. 10 Fluid And Electrolyte Imbalances Nursing Care Plans: Endocrine and Metabolic Care Plans [Internet]. 2017 [cited 2019 Jan 23]. Available from: <https://nurseslabs.com/fluid-electrolyte-imbbalances-nursing-care-plans/2/>
 42. Adeleye o, Faulkner M, Adeola Tolulola, ShuTangyie Shu. HYPERNATREMIA IN THE ELDERLY. *Journal of the Medical Association*. 2002;94(2):701–5.
 43. Oates LL, Price CI. Clinical assessments and care interventions to promote oral hydration amongst older patients: a narrative systematic review. *BMC Nurs*. 2017;164. doi:10.1186/s12912-016-0195-x
 44. Schram MT, et al. Setting and registry characteristics affect the prevalence and nature of multimorbidity in the elderly. *J Clin Epidemiol*. 2008;61(11):1104–12. doi:10.1016/j.jclinepi.2007.11.021
 45. Kear TM. Fluid and Electrolyte Management Across the Age Continuum. *Nephrol Nurs J*. 2017;44(6):491–6.
 46. Mohammadifard N, Gotay C, Humphries KH, Ignaszewski A, Esmaillzadeh A, Sarrafzadegan N. Electrolyte minerals intake and cardiovascular health. *Crit Rev Food Sci Nutr*. 2018;1–11. doi:10.1080/10408398.2018.1453474
 47. Eliacik E, et al. Potassium abnormalities in current clinical practice: frequency, causes, severity and management. *Med Princ Pract*. 2015;24(3):271–5. doi:10.1159/000376580
 48. Liamis G, Rodenburg EM, Hofman A, Zietse R, Stricker BH, Hoom EJ. Electrolyte disorders in community subjects: prevalence and risk factors. *Am J Med*. 2013;126(3):256–63. doi:10.1016/j.amjmed.2012.06.037
 49. Metheny NM, editor. Fluid and electrolyte balance: Nursing considerations. 5th ed. Sudbury, MA: Jones & Bartlett Learning; 2012. vii, 398.
 50. Belleza M. Fluids and Electrolytes, Acid-Base Balance: Nursing Care Management and Study Guide [Internet]. 2017 [cited 2019 Jan 23]. Available from: <https://nurseslabs.com/fluid-and-electrolytes/#nursing-assessment>
 51. Abdulfattah O, Rahman EU, Alnafoosi Z, Schmidt F. Severe hypokalemia with cardiac arrest as an unusual manifestation of alcoholism. *J Community Hosp Intern Med Perspect*. 2018;8(5):285–91. doi:10.1080/20009666.2018.1514943
 52. Nitti VW. The Prevalence of Urinary Incontinence. *Rev Urol*. 2001;3(Suppl 1):S2–6.
 53. Onder G, et al. Polypharmacy in nursing home in Europe: results from the SHELTER study. *J Gerontol A Biol Sci Med Sci*. 2012;67(6):698–704. doi:10.1093/geronol/67.6.698
 54. Dharmarajan TS, Nguyen T, Russell RO. Life-threatening, preventable hyperkalemia in a nursing home resident: case report and literature review. *Journal of the American Medical Directors Association*. 2005;6(6):400–5. doi:10.1016/j.jamda.2005.07.006
 55. Schlanger LE, Bailey JL, Sands JM. Electrolytes in the aging. *Adv Chronic Kidney Dis*. 2010;17(4):308–19. doi:10.1053/j.ackd.2010.03.008
 56. Leichsenring K, Lamontagne-Godwin F, Schmidt A. Performance measurement in long-term care in Austria. In: *Regulating long-term care quality: an international comparison*. Cambridge [u.a.]: Cambridge Univ. Press; 2014. p. 32–66. eng.
 57. Ágotnes G, McGregor MJ, Lexchin J, Doupe MB, Müller B, Harrington C. An International Mapping of Care in Nursing Homes. *Health Serv Insights*. 2019;12:1178632918825083. doi:10.1177/1178632918825083
 58. Sozialgesetzbuch (SGB) - Elftes Buch (XI) - Soziale Pflegeversicherung. Bundesministerium der Justiz und für Verbraucherschutz; 6. Mai 2019 (BGBl. I S. 646) [cited 2019 May 20].
 59. Benetos A, et al. Pragmatic diabetes management in nursing homes: individual care plan. *Journal of the American Medical Directors Association*. 2013;14(11):791–800. doi:10.1016/j.jamda.2013.08.003
 60. Mentes JC, Wang J. Measuring risk for dehydration in nursing home residents: evaluation of the dehydration risk appraisal checklist. *Res Gerontol Nurs*. 2011;4(2):148–56. doi:10.3928/19404921-20100504-02
 61. Guigoz Y. The Mini Nutritional Assessment (MNA) review of the literature—What does it tell us? *J Nutr Health Aging*. 2006;10(6):466–85; discussion 485–7.
 62. Dellefield ME. Implementation of the resident assessment instrument/minimum data set in the nursing home as organization: implications for quality improvement in RN clinical assessment. *Geriatr Nurs*. 2007;28(6):377–86. doi:10.1016/j.gerinurse.2007.03.002
 63. Kieft RA, Brouwer BBJM de, Francke AL, Delnoij DMJ. How nurses and their work environment affect patient experiences of the quality of care: a qualitative study. *BMC Health Serv Res*. 2014;14:249. doi:10.1186/1472-6963-14-249
 64. Francis RQC, editor. Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry: The Mid Staffordshire NHS Foundation Trust. London: The Stationery Office; 2013 [cited 2019 May 16]. (vol. 13).
 65. Means T. Improving quality of care and reducing unnecessary hospital admissions: a literature review. *Br J Community Nurs*. 2016;21(6):284, 288–91. doi:10.12968/bjcn.2016.21.6.284
 66. Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Irtun Ø. Nutritional routines and attitudes among doctors and nurses in Scandinavia: a questionnaire based survey. *Clin Nutr*. 2006;25(3):524–32. doi:10.1016/j.clnu.2005.11.011
 67. Mowe M, et al. Insufficient nutritional knowledge among health care workers? *Clin Nutr*. 2008;27(2):196–202. doi:10.1016/j.clnu.2007.10.014
 68. El-Sharkawy AM, Sahota O, Maughan RJ, Lobo DN. The pathophysiology of fluid and electrolyte balance in the older adult surgical patient. *Clin Nutr*. 2014;33(1):6–13. doi:10.1016/j.clnu.2013.11.010
 69. Katz J, Peace SM, editors. End of life in care homes: A palliative approach. Oxford, New York: Oxford University Press; 2003. 205 p. eng.