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Potentially avoidable Hospitalisations of German Nursing Home Patients: Utilisation-Patterns and Consequences

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10 **Abstract**

11 **Objectives** Demand for nursing home (NH) care is soaring due to gains in life expectancy

12 and people living longer with chronic illness and disability. This is dovetailing with work-

13 force shortages across the health professions. Access to timely and appropriate medical

14 care for NH residents is becoming increasingly challenging and can result in potentially

15 avoidable hospitalisations (PAHs). In light of these factors, we analyzed PAHs comparing

16 NH patients with Non-NH patients.

17 **Design** Cross-sectional study with claims data from 2015 supplied by a large German

18 health insurance company within the federal state of Baden-Wuerttemberg.

19 **Setting** One year observation of hospitalisation patterns for NH and Non-NH patients.

20 **Participants** 3,872,245 of the 10.5 Million inhabitants of Baden-Wuerttemberg were

21 covered.

22 **Methods** Patient data about hospitalisation date, sex, age, level of care and diagnoses

23 were available. PAHs were defined based on ICD-10 diagnoses belonging to Ambulatory

24 Care Sensitive Conditions (ACSCs). Adjusted odds ratios for PAHs for NH patients in

25 comparison to Non-NH patients were calculated with multivariable regression models.

26 **Results** Of the 933,242 hospitalisations in 2015, there were 23,982 for 13,478 NH pa-

27 tients and 909,260 for 560,998 Non-NH patients. Mean age of hospitalised NH patients

28 and level of care were significantly higher than those of Non-NH patients. 6,449 PAHs

29 (29.6%) for NH patients and 136,543 PAHs (15.02%) for Non-NH patients were identi-

30 fied. The adjusted odds ratio for PAHs was significantly heightened for NH patients in

31 comparison to Non-NH patients (OR: 1.22, CI:[1.18, 1.26], p< 0.0001). Moreover, we

32 could observe that more than 90% of PAHs with ACSCs were unplanned.

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33 **Conclusions** Large numbers of PAHs for NH patients calls for improved coordination of

34 medical care, especially GP service provision. Introduction of targeted training programs

35 for physicians and NH staff on health problem management for NH patients can con-

36 tribute to reduction of potentially avoidable hospital admissions.

37 **Strengths and limitations of this study**

38 • The evaluation reports on a comprehensive sample of data of one year covering
39   one whole federal state of Germany.
40 • This is the first study comparing potentially avoidable hospitalisations of nursing
41   home residents with people living at home.
42 • It was possible to separate planned from unplanned hospitalisations.
43 • The assessment of concept of "potentially avoidable hospitalisations" depends
44   on the specific context of each case.
45 • The real need for long time care could only be approximated by the level of care
46   in the data set.

47

48 **Keywords** Nursing Homes; potentially avoidable hospitalisations; unplanned hospitalisa-

49 tions; Ambulatory Care-Sensitive Conditions; Out-of-Hours Care.

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Background

Demand for nursing home (NH) care is soaring due to gains in life expectancy and people living longer with chronic illness and disability. In Germany between 2013 and 2015 the number of nursing increased by 4.6%. In 2015, a number of 783,000 nursing home residents was observed. This is comparable with the situation in France. However, access to timely and appropriate medical care for NH residents is becoming increasingly challenging with frequency of home visits to nursing home residents rising in both regular and Out-of-Hours care (OOHC).[1-4] Provision of medical care to nursing home residents in Germany is predominantly provided by general practitioners (GPs), but this increasing demand for health care services is dovetailing with workforce shortages across the health professions including general practitioners. This is leading to gaps in care provision for NH-residents and an increasing burden in terms of workload for GPs, especially in rural areas.[4,5]

This is exacerbated by a further problem in terms of the knowledge base and skill sets of nursing staff traditionally educated to work in German nursing homes (*Altenpflege)*. Laws governing the curriculum, i.e. required theoretical content and hours plus required clinical practice hours for the three-year *Altenpflege* vocational nursing training, have not been updated since 2003, but in the subsequent 15-years, care needs of nursing home residents have become increasingly more complex as people live longer with chronic illness and co-morbidities.[6] There is a distinct need for upskilling and expansion of the roles and responsibilities of nursing staff working in German nursing homes. Workforce shortages in this occupational group as well as lacking competencies result in an increased burden to nurses and contribute to potentially avoidable hospitalisations.[7-9] Meanwhile, nursing home residents experience the consequences of these system is-

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76   sues at an individual level including discomfort to themselves, potentially increased risk

77   of morbidity due to iatrogenic events, potential deterioration of dementia or delirious

78   behaviors not to mention the financial implications related to potentially avoidable hos-

79   pitalisations.[10]

80   NHs residents have been associated with high rates of emergency department (ED) visits

81   and a high rate of hospitalisations, which is not just a problem in the German health

82   care system. Several international studies point in the direction that a large number

83   hospitalisations for NH-residents are potentially hasty.[10-14] Common conditions of nurs-

84   ing home residents presenting to ED are pneumonia, falls with injuries, urinary tract

85   infections, dehydration, partly as part of digestive problems often combined with pre-

86   existing dementia.[15-18] These all fall under the umbrella of 'ambulatory care-sensitive

87   conditions' (ACSCs), which in the ICD-10 codes include the most prevalent conditions for

88   hospitalisations, which could potentially be handled on an outpatient basis. [19]

89   The aim of this study was to identify potentially avoidable hospitalisations (PAHs) of pa-

90   tients living in NHs and to compare these hospitalisations rates with the PAH rates of

91   patients living at home. We distinguished between planned and unplanned hospitalisa-

92   tions (UHs). Our hypothesis was that the rate of PAHs from NHs would be significantly

93   higher than of patients living at home.

94   **Methods**

95   *Setting, Design and Participants*

96   Inpatient diagnoses of insured individuals living at home and of residents living in nurs-

97   ing homes supplied by the AOK ("Allgemeine OrtsKrankenkasse"), a statutory health

98   insurance company within the Federal State Baden-Wuerttemberg were analysed in

5

99 order to determine PAHs. All inpatient ICD-10 diagnoses in 2015 were screened for an

100 established set of ACSCs compiled by health services researchers of the Department of

101 General Practice and Health Services Research, University Hospital Heidelberg according

102 to already published lists of ACSCs. [19-21] The included conditions are shown in the Sup-

103 plemental Table 1.

104 Data were derived from a comprehensive evaluation programme in German primary

105 care, the *Hausarztzentrierte Versorgung* (HZV), loosely translated as "family doctor co-

106 ordinated care". The HZV is a programme encouraging patients to enrol with a family

107 doctor pursuant to Section 73b, Volume V of the German Social Security Law. It came

108 into effect in Baden-Wuerttemberg on July 1st, 2008. The HZV is aimed at enhancing

109 health care for patients with chronic diseases and complex health care needs e. g. those

110 requiring long-term care.[22]

111 In Germany, the rules for determining level of care for all patients depend on the severi-

112 ty of disease and multi-morbidity. The level of care category assigned then determines

113 the financial support available for continuous care from the health care insurance pro-

114 viders. [23] Until 2016, patients could be categorised into one of four levels of care from 0

115 to 3. These levels include assessed needs for both basic nursing care and specialised

116 medical care. For example, patients who required basic nursing care of less than 0.75

117 hours per day were categorised in level 0, patients who needed more than four hours

118 basic nursing care per day and additionally required complex medical care were catego-

119 rised in level 3. Since 2017, the level of care categories have been extended from 0 to 5

120 in order to include patients with incipient and advanced dementia who are otherwise

121 physically healthy.[24]

122   The items of the level of care classification in Germany may be approximately compara-

123   ble with the key issues of the management of people with long term conditions in Eng-

124   land of Goodwin et al. describing five vital areas of long-term conditions (LTCs) and the

125   social care long term conditions model with quality requirements. The effectivity of the

126   new care models are currently examined and evaluated in different vanguards spread

127   across England.[25-27]

128   *Data*

129   The eligible study population consisted of 3.872 million individuals with statutory health

130   insurance from AOK. The insurance claims data included diagnosis, date of hospitalisa-

131   tion, age and sex of the individuals and planned or unplanned hospitalisations. An un-

132   planned or emergency case could be identified in the forms of hospitalisation recorded

133   in the available dataset by the health insurance company. Age and gender was available

134   for every patient within the dataset. Based on the ICD-10, it was possible to determine

135   the "Charlson-Index" in order to approximate patients' overall morbidity. There are par-

136   ticular diagnoses corresponding to more severe conditions. Values between 1 and 6 are

137   assigned for those diagnoses. Finally, a sum score is determined for each individual. The

138   underlying calculus is described in detail elsewhere.[28]

139   Data storage and extraction was performed with MySQL Community Server x64 (Oracle

140   Corporation, Redwood Shores, CA, USA).

141   *Statistical Methods*

142   Multivariable analyses were performed with regard to patients' age, gender, morbidity

143   and the binary variable for participation in the HZV intervention. Moreover, level of care

144   for each patient in the multivariable model was included.

7

145 In order to calculate frequencies, rates and percentages we used SAS PROC SQL. In order

146 to assess the adjusted outcomes of interest, we used SAS PROC GENMOD (SAS 9.4 x64,

147 SAS Institute Inc., Cary, NC, USA).[29]

148 For all analyses, results were considered statistically significant if the p value was 0.05 or

149 less.

150 *Outcomes*

151 Potentially avoidable hospitalisations of individuals living at home and of individuals

152 living in nursing homes were the primary outcome measures in this study. The compari-

153 son of planned and unplanned hospitalisations was an additional outcome.

154 *Ethics*

155 Ethical approval for the study was given by the University Hospital Heidelberg Ethics

156 Committee (No. S-359/2013).

157 *Patient and public involvement*

158 Patients of the study could not be informed and involved because we used pseudony-

159 mized data. It was not possible to identify patients. The dissemination of the results will

160 be performed by publications publicly accessible.

161

162 **Results**

163 *Observed Sample*

164 The sample drawn from the AOK statutory health insurance provider dataset included

165 13,478 hospitalised patients from an overall population of 31,079 nursing home resi-

166 dents and 560,998 hospitalised patients from an overall population of 3,841,166 AOK

167 insured persons living at home (Table 1).

8

168   Table 1. Observed Sample, Unadjusted hospitalisation patterns

	Patients living		
	…in Nursing Home	… not in Nursing Home	P-Value
Number of patients	31,079	3,841,166	-
Number of hospitalized patients	13,478	560,998	-
Number of readmissions	23,982	909,260	-
Hospitalization rate (per 100 patients per year)	77.16	23.67	< 0.0001
Potentially avoidable hospitalizations (n, %)	6,449 (26.89%)	136,543 (15.02%)	< 0.0001
Emergency/OOHC hospitalizations (n, %)	15,647 (65.24%)	398,167 (43.79%)	< 0.0001

169

Description of the included population

171   Mean age of hospitalised patients living in nursing homes was 80.58 ± 13.31 years with

172   significantly more women in this group than in the patient group living at home (68.56%

173   versus 53.64%). In comparison, the mean age of the hospitalised patients living at home

174   was 55.52 ± 24.66 years. Hospitalised nursing home patients suffered from more chronic

175   diseases. In this study, level of care category for nursing home patients was significantly

176   higher than for patients living at home (1.82±0.76 versus 0.17 ± 0.52). HZV enrolment

177   ("family doctor coordinated care") for hospitalised nursing home patients was some-

178   what lower than for hospitalised patients living at home (Table 2).

179   Table 2. Demographics of <u>hospitalised</u> patients

	Patients living		
	…in Nursing Home	… not in Nursing Home	P-Value
Number of Patients	13,478	560,998	-
Age (AVG ± SD)	80.58 ± 13.31	55.52 ± 24.66	< 0.0001
Gender (% female)	68.56%	53.64%	< 0.0001
Morbidity (AVG ± SD)	4.32 ± 2.76	2.23 ± 2.65	< 0.0001
Level of Care Category (AVG ± SD)	1.82 ± 0.76	0.17 ± 0.52	< 0.0001
HZV Enrolment (% participation)	31.19%	38.88%	< 0.0001

180   *Hospitalisations patterns*

181   In total, 23,982 hospitalisations of patients living in nursing homes and 909,260 hospital-

182   isations of patients living at home were evaluated for the 2015 period. This means a

183   hospitalisation rate of 77.16% versus 23.67% in the two different study groups. 15,647

184   hospitalisations of the nursing home patients were either unplanned or hospitalisations

185   due to an emergency (65.24%). In comparison, 398,167 of the 909,260 hospitalisations

186   of patients living at home were unplanned (43.79%). This was a significantly higher pro-

187   portion of unplanned hospitalisations for nursing home residents in comparison to pa-

188   tients living at home (Table1).

189   *Comparison of Ambulatory Care Sensitive Conditions (ACSCs) of nursing home patients*
190   *and patients living at home*

191   6,449 potentially avoidable hospitalisations of nursing home patients (26.9%) and

192   136,543 potentially avoidable hospitalisations of patients living at home (15.02%) were

193   identified. Comparing the two study populations, there was a significant increase in the

194   relative rate (79.03%) of ACSCs in the nursing home group. The adjusted odds ratios for

195   patients living in nursing homes were significantly higher than the patient group living at

196   home for potentially avoidable hospitalisations as well as for unplanned hospitalisations

197   (Table 3). In addition, 90.87% of PAHs with ACSCs were not in the category of planned

198   hospitalisations. By implication, less than 10% of PAHs were planned hospitalisations.

199   Table 3. Adjusted odds ratios for hospitalisation target variables. (Nursing home patients
200   versus patients living at home)

	Odds Ratio	95%-CI	P-Value
Potentially avoidable hos-pitalizations	1.222	[1.184, 1.262]	< 0.0001
Unplanned (Emergency/ OOHC) hospitalizations	1.505	[1.462, 1.549]	< 0.0001

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202

203 The top ten potentially avoidable hospitalisations according to ACSC category for both

204 groups are shown in Table 4. Pneumonia (J18), Fracture of Femur (S72), Volume deple-

205 tion E86) and Epilepsy (G40) occurred noticeably more often in nursing home patients.

206 Table 4. Top ten potentially avoidable hospitalisations according to ACSC category.

		Nursing Home Patients					Non Nursing Home Patients		
Rank	ICD-10 Code	Diagnosis	n	%	Rank	ICD-10 Code	Diagnosis	n	%
1	J18	Pneumonia	1,196	18.52	1	I50	Heart failure	21,775	15.94
2	I50	Heart failure	1,137	17.61	2	F10	Disorders due to use of alcohol	16,204	11.86
3	S72	Fracture of femur	827	12.81	3	J18	Pneumonia	12,195	8.93
4	E86	Volume depletion	588	9.11	4	I20	Angina pectoris	11,474	8.40
5	G40	Epilepsy	549	8.50	5	I10	Essential (primary) hypertension	9,574	7.01
6	E11	Type 2 diabetes mellitus	332	5.14	6	S72	Fracture of femur	6,868	5.03
7	J20	Acute bronchitis	278	4.31	7	E11	Type 2 diabetes mellitus	6,262	4.58
8	K21	Gastro-oesophageal reflux disease	180	2.79	8	G40	Epilepsy	6,189	4.53
9	I10	Essential (primary) hypertension	170	2.63	9	J20	Acute bronchitis	4,654	3.41
10	K59	Other functional intestinal disorders	120	1.86	10	E86	Volume depletion	4,434	3.25

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208

209 **Discussion**

210 The analysis of the AOK statutory health insurance provider dataset identified numerous

211 PAHs especially in the context of UHs (including emergency and OOHC). 23,982 hospital-

212 isations of nursing home patients and 909,260 hospitalisations of patients living at home

213 occurred in 2015. Comparing the number of PAHs in both patient groups, the adjusted

214 odds ratios for UHs and for PAHs were significantly higher in the NH group. These results

215 are in accordance with several other international studies, which in particular identify

216 the need for improved continuity of care for people in nursing homes.[10,12-15,30] Haber et

217 al. showed in their study that consistency of the relationship between GP and nursing

218 home patient was an important factor of reducing potentially avoidable hospitalisations

219 and of reducing OOHC or ED visits.[31] It is of great importance that medical practitioners

11

220 (usually GPs) know the medical history of nursing home residents to ensure optimal care

221 management of patient health needs and to coordinate care between providers as well

222 as to anticipate potential deterioration of patient health conditions and therefore re-

223 duce unnecessary utilisation of acute hospital services.[10,32]

224 NH patients with ACSCs who do not have a primary health care provider in regular at-

225 tendance will be potentially frequent attenders in OOHC and EDs.[33,34] The overcrowding

226 of OOHC centers and EDs is as well as PAHs of NH patients are stretching resources to

227 the limits in health care systems of many European countries and the United States of

228 America.[35,36] Frequent attenders or patients with minor ailments are in large part re-

229 sponsible for the high workload of physicians and staff in OOHC and EDs.

230 Consultations of these patients with minor ailments in OOHC or EDs should be avoided,

231 except for the most urgent or complex cases.[37-39] However, this is creating the need for

232 new approaches to conditions such as pneumonia, falls risk (e.g. to prevent fracture of

233 femur), volume depletion and epilepsy, which are four of the most frequent diagnoses

234 connected with potentially avoidable hospitalisations in our study and common prob-

235 lems in nursing homes.[16,40,41] Prophylactic and monitoring procedures for these condi-

236 tions are possible and do not seem to be too complex in the first instance. However,

237 individually tailored prophylactic and monitoring procedures for nursing home residents

238 are resource intensive in terms of both time and staff and, due to resource constraints

239 and workforce shortages, are a major cause of current deficiencies in care provision.

240 In times of an increasing shortage of primary care providers specifically GPs and of insuf-

241 ficient nursing home staff, health policies and health services experts have to look for

242 innovative approaches to ease the health care services crisis emerging in nursing homes.

243 In addition, it is also of importance that nursing home staff are formally empowered to

244 manage minor ailments like fever and pain in the first instance. Currently in Germany,

245 this is a limitation as a high proportion of staff in nursing homes lack the required com-

246 petencies and training and, furthermore, government regulations prohibit independent

247 clinical decisions of nursing staff in nursing homes and require them to be made in con-

248 sultation with a medical practitioner.[42,43]

249 In Germany, the current government has introduced a new policy to address this press-

250 ing problem and agreed to fund 8,000 new geriatric nurses (*Altenpflege*) with enhanced

251 competencies for nursing homes through the statutory health insurance.[44] The policy for

252 upskilling a segment of the geriatric nursing workforce is one important step but will not

253 bring immediate improvements to coordination of care and information flow between

254 the different providers across health care sectors. Potentially avoidable hospitalisations

255 of nursing home residents and effective outpatient management remain complex prob-

256 lems that must be dealt with in parallel on many fronts.

257 The complex difficulties in improving the care of nursing home residents were shown in

258 the INTERACT-program (Interventions to reduce Acute Care Transfers) a randomised

259 prospective study. Despite training and support of the staff, the objectives of reducing

260 hospital admissions or ED visits for NH residents were not achieved.[42] Kane at al. explain

261 the lack of effectiveness are being due to a multitude of interacting factors: Quality of

262 the NH staff, lacking continuous medical care, concerns over liability and poor motiva-

263 tion to reduce hospitalisations in nursing home patients.[42]

264 Perhaps in future service providers such as nurse practitioners, physician assistants – in

265 Germany VERAH (*Versorgungsassistentin in der Hausarztpraxis*)- palliative care teams,

266 geriatric specialist services may support primary care providers (GPs) and nursing home

267 staff in improving medical care and reducing potentially avoidable hospital admissions

268 of nursing home residents.[10,45-47] However the effects of these new models or interven-

269 tions are low and should be studied further.[47]

270 A further initiative by the German government has been the introduction of the "Inno-

271 vation Fund". With this programme, health services research projects are subsidised,

272 and this includes among others, pilot projects to improve the care of nursing home resi-

273 dents and to reduce potentially avoidable hospitalisations. It remains to be seen, if the

274 results of these projects translate to improved responsiveness to the needs of nursing

275 home residents.[48-50]

276 Finally, the issue of remuneration needs to be addressed. High workloads, dealing with

277 the impacts of staff shortages and increasingly complex patient care requirements in the

278 primary care sector, place a burden on the existing workforce. GPs, other specialists and

279 nursing staff should also be remunerated adequately and advanced training to upskill

280 staff should be incentivised. In that respect, NHs, insurance companies and the govern-

281 ment are called upon to give financial incentives.[4,10,51,52]

282

283 **Conclusions**

284 A high rate of UHs and of PAHs especially for nursing home residents suggests that the

285 health care provision in NHs needs improvement. At the individual level, physicians in

286 primary care and OOHC and the staff in NHs have to be sensitised to manage common

287 health problems of patients that too often result in UHs and PAHs. Prerequisites for im-

288 proved inter-sectoral collaboration are sufficient numbers of nursing home staff, up-

289 skilled with today's needed competencies and GPs/primary care medical specialists who

14

290   are motivated to upskill in geriatric health care. Finally, at a system level, policy makers

291   and regulators of the health professions need to use incentives and remuneration pro-

292   grams to achieve the ambitious goals of improving nursing home care and reducing po-

293   tentially avoidable hospitalisations of nursing home residents.

294   **Author Contributions** GL, JS and RL initiated and designed the study. GL and RL coordi-
295   nated the study. GL carried out data analysis. RL, SB (native English speaker) and GL
296   wrote the manuscript. All authors (RL, SB, JS and GL) commented on the draft and ap-
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302   **Competing interests** None declared

303   **Patient consent** Not required

304   **Data sharing statements** Data used in this analysis are not in the public domain an use
305   was covered by data sharing agreements with the AOK Baden-Wuerttemberg.

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481   **Appendix**

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483   Supplement 1: List of ICD 10-GM Codes Used to Identify Hospitalizations for Ambulatory
484   Care–Sensitive Conditions

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Supplement 1

Supplemental Table 1. List of ICD 10-GM Codes Used to Identify Hospitalizations for Ambulatory Care–Sensitive Conditions	
Ambulatory Care Sensitive Condition	*ICD10-GM Code*
Angina	I20, I24.0, I24.8, I24.9
Asthma	J45, J46
Cellulitis	L03, L04, L08.0, L08.8, L08.9, L88, L98.0
Congestive heart failure	I11.0, I50, J81
Convulsion and epilepsy	G40, G41, R56, O15
Chronic obstructive pulmonary disease	J20, J41, J42, J43, J47
Dehydration and gastroenteritis	E86, K52.2, K52.8, K52.9
Dental conditions	A69.0, K02, K03, K04, K05, K06, K08, K09.8, K09.9, K12, K13
Diabetes complications	E10.0–E10.8, E11.0–E11.8, E12.0–E12.8, E13.0–E13.8, E14.0– E14.8
Ear, nose and throat infections	H66, H67, J02, J03, J06, J31.2
Gangrene	R02
Hypertension	I10, I11.9
Influenza and pneumonia	J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18
Iron-deficiency anemia	D50.1, D50.8, D50.9
Nutritional deficiency	E40, E41, E42, E43, E55.0, E64.3
Other vaccine preventable diseases	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4
Pelvic inflammatory disease	N70, N73, N74
Perforated/bleeding ulcer	K25.0–K25.2, K25.4–K25.6, K26.0–K26.2, K26.4–K26.6, K27.0–K27.2, K27.4–K27.6, K280–282, K284–K286
Pyelonephritis	N10, N11, N12, N13.6
Alcohol-related diseases	F10
Atrial fibrillation and flutter	I47.1, I47.9, I49.5, I49.8, I49.9, R00.0, R002, R00.8
Constipation	K59.0
Fractured proximal femur	S72.0, S72.1, S72.2
Dyspepsia and other stomach function disorders	K30, K21
Hypokalemia	E87.6
Migraine/acute headache	G43, G44.0, G44.1, G44.3, G44.4, G44.8, R51x
ICD-10-GM = International Classification of Diseases-, 10th Revision – German Modification.	

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Potentially avoidable hospitalisations of German nursing home patients? A cross-sectional study on utilisation patterns and potential consequences for health care

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1 **Potentially avoidable hospitalisations of German nursing home patients? A cross-**
2 **sectional study on utilisation patterns and potential consequences for health care**

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1

Abstract

Objectives Demand for nursing home (NH) care is soaring due to gains in life expectancy and people living longer with chronic illness and disability. This is dovetailing with workforce shortages across the health professions. Access to timely and appropriate medical care for NH residents is becoming increasingly challenging and can result in potentially avoidable hospitalisations (PAHs). In light of these factors, we analysed PAHs comparing NH patients with Non-NH patients.

Design Cross-sectional study with claims data from 2015 supplied by a large German health insurance company within the federal state of Baden-Wuerttemberg.

Setting One year observation of hospitalisation patterns for NH and Non-NH patients.

Participants 3,872,245 of the 10.5 Million inhabitants of Baden-Wuerttemberg were covered.

Methods Patient data about hospitalisation date, sex, age, nationality, level of care and diagnoses were available. PAHs were defined based on ICD-10 diagnoses belonging to Ambulatory Care Sensitive Conditions (ACSCs). Adjusted odds ratios for PAHs for NH patients in comparison to Non-NH patients were calculated with multivariable regression models.

Results Of the 933,242 hospitalisations in 2015, there were 23,982 for 13,478 NH patients and 909,260 for 560,998 Non-NH patients. Mean age of hospitalised NH patients and level of care were significantly higher than those of Non-NH patients. 6,449 PAHs (29.6%) for NH patients and 136,543 PAHs (15.02%) for Non-NH patients were identified. The adjusted

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3   31   odds ratio for PAHs was significantly heightened for NH patients in comparison to Non-NH
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5   32   patients (OR: 1.22, CI:[1.18, 1.26], p< 0.0001). Moreover, we could observe that more than
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7   33   90% of PAHs with ACSCs were unplanned (UHs).
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10   34   **Conclusions** Large numbers of PAHs for NH patients calls for improved coordination of
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12   35   medical care, especially GP service provision. Introduction of targeted training programs for
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14   36   physicians and NH staff on health problem management for NH patients could perhaps
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16   37   contribute to reduction of PAHs, predominantly UHs.
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19   38   **Strengths and limitations of this study**
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22   39   • The evaluation reports on a comprehensive sample of data of one year covering one
23   40   whole federal state of Germany.
24   41   • This is the first study comparing potentially avoidable hospitalisations of nursing
25   42   home residents with people living at home.
26   43   • It was possible to separate planned from unplanned hospitalisations.
27   44   • Our study design did not allow for remarks about sociodemographic data of the
28   45   study population.
29   46   • Information on the staffing ratio or the education of the nursing home staff was not
30   47   available to us.
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32   48
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35   49   **Keywords** Nursing Homes; potentially avoidable hospitalisations; unplanned
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37   50   hospitalisations; Ambulatory Care-Sensitive Conditions; Out-of-Hours Care.
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Background

Demand for nursing home (NH) care is soaring due to gains in life expectancy and people living longer with chronic illness and disability. In Germany between 2013 and 2015 the number of nursing increased by 4.6%. In 2015, a number of 783,000 nursing home residents were observed. This is comparable with the situation in France. However, access to timely and appropriate medical care for NH residents is becoming increasingly challenging with frequency of home visits to nursing home residents rising in both regular and Out-of-Hours care (OOHC).[1-4] Provision of medical care to nursing home residents in Germany is predominantly provided by general practitioners (GPs), but this increasing demand for health care services is dovetailing with workforce shortages across the health professions including general practitioners. This is leading to gaps in care provision for NH-residents and an increasing burden in terms of workload for GPs, especially in rural areas.[4,5]

This is exacerbated by a further problem in terms of the knowledge base and skill sets of nursing staff traditionally educated to work in German nursing homes (*Altenpflege)*. Laws governing the curriculum, i.e. required theoretical content and hours plus required clinical practice hours for the three-year *Altenpflege* vocational nursing training, have not been updated since 2003, but in the subsequent 15-years, care needs of nursing home residents have become increasingly more complex as people live longer with chronic illness and co-morbidities.[6] There is a distinct need for upskilling and expansion of the roles and responsibilities of nursing staff working in German nursing homes. Workforce shortages in this occupational group, as well as lacking competencies, result in an increased burden to nurses and contribute to potentially avoidable hospitalisations.[7-9] Meanwhile, nursing home

75 residents experience the consequences of these system issues at an individual level

76 including discomfort to themselves, potentially increased risk of morbidity due to iatrogenic

77 events, potential deterioration of dementia or delirious behaviours not to mention the

78 financial implications related to potentially avoidable hospitalisations.[10]

79 NHs residents have been associated with high rates of emergency department (ED) visits

80 and a high rate of hospitalisations, which is not just a problem in the German health care

81 system. Several international studies point in the direction that a large number

82 hospitalisations for NH-residents are potentially avoidable.[10-14] Common conditions of

83 nursing home residents presenting to ED are pneumonia, falls with injuries, urinary tract

84 infections, dehydration, partly as part of digestive problems often combined with pre-

85 existing dementia.[15-18] These all fall under the umbrella of 'ambulatory care-sensitive

86 conditions' (ACSCs), which in the ICD-10 codes include the most prevalent conditions for

87 hospitalisations, which could potentially be handled on an outpatient basis. [19]

88 The aim of this study was to identify potentially avoidable hospitalisations (PAHs) of

89 patients living in NHs and to compare these hospitalisations rates with the PAH rates of

90 patients living at home. We distinguished between planned and unplanned hospitalisations

91 (UHs). Our hypothesis was that the rate of PAHs from NHs and thereof the UHs would be

92 significantly higher than of patients living at home.

93 **Methods**

94 *Setting, Design and Participants*

95 Inpatient diagnoses of insured individuals living at home and of residents living in nursing

96 homes supplied by the AOK ("Allgemeine OrtsKrankenkasse"), a statutory health insurance

97 company within the Federal State Baden-Wuerttemberg were analysed in order to

98 determine PAHs. All inpatient ICD-10 diagnoses in 2015 were screened for an established

99 set of ACSCs compiled by health services researchers of the Department of General Practice

100 and Health Services Research, University Hospital Heidelberg according to already published

101 lists of ACSCs. [19-21] The included conditions are shown in the Supplemental Table 1.

102 Data were derived from a comprehensive evaluation programme in German primary care,

103 the *Hausarztzentrierte Versorgung* (HZV), loosely translated as "family doctor coordinated

104 care". The HZV is a programme encouraging patients to enrol with a family doctor pursuant

105 to Section 73b, Volume V of the German Social Security Law. It came into effect in Baden-

106 Wuerttemberg on July 1st, 2008. The HZV is aimed at enhancing health care for patients

107 with chronic diseases and complex health care needs e. g. those requiring long-term care.[22]

108 In Germany, the rules for determining level of care for all patients depend on the severity of

109 disease and multi-morbidity. The level of care category assigned then determines the

110 financial support available for continuous care from the health care insurance providers. [23]

111 Until 2016, patients could be categorised into one of four levels of care from 0 to 3. These

112 levels include assessed needs for both basic nursing care and specialised medical care. For

113 example, patients who required basic nursing care of less than 0.75 hours per day were

114 categorised in level 0, patients who needed more than four hours basic nursing care per day

115 and additionally required complex medical care were categorised in level 3. Since 2017, the

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116 level of care categories have been extended from 0 to 5 in order to include patients with

117 incipient and advanced dementia who are otherwise physically healthy.[24]

118 The new outpatient models of care introduced by the NHS in England for patients with long

119 term conditions may be approximately comparable with the models of care in Germany.

120 The five vital areas of long-term conditions (LTCs) described in these social models of care

121 correspond to the items of level of care classification in Germany. The implementation of

122 the models of care in daily routine are currently examined and evaluated in different

123 vanguards spread across England.[25-27]

124

125 *Data*

126 The eligible study population consisted of 3.872 million individuals with statutory health

127 insurance from AOK. The insurance claims data included diagnosis, date of hospitalisation,

128 age, sex and nationality of the individuals. An UH could be identified in the forms of

129 hospitalisation recorded in the available dataset by the health insurance company. Age,

130 gender and nationality were available for every patient within the dataset. Based on the

131 ICD-10, it was possible to determine the "Charlson-Index" in order to approximate patients'

132 overall morbidity. There are particular diagnoses corresponding to more severe conditions.

133 Values between 1 and 6 are assigned for those diagnoses. Finally, a sum score is

134 determined for each individual. The underlying calculus is described in detail elsewhere.[28]

135 Data storage and extraction was performed with MySQL Community Server x64 (Oracle

136 Corporation, Redwood Shores, CA, USA).

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Statistical Methods

141 Multivariable analyses were performed with regard to patients' age, gender, nationality,

142 morbidity and the binary variable for participation in the HZV intervention. Moreover, level

143 of care for each patient in the multivariable model was included.

144 In order to calculate frequencies, rates and percentages we used SAS PROC SQL. In order to

145 assess the adjusted outcomes of interest, we used SAS PROC GENMOD (SAS 9.4 x64, SAS

146 Institute Inc., Cary, NC, USA).[29]

147 For all analyses, results were considered statistically significant if the p value was 0.05 or

148 less.

Outcomes

150 PAHs of individuals living at home and of individuals living in nursing homes were the

151 primary outcome measures in this study. The comparison of planned and unplanned

152 hospitalisations was an additional outcome.

Ethics

154 Ethical approval for the study was given by the University Hospital Heidelberg Ethics

155 Committee (No. S-359/2013).

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156   *Patient and public involvement*

157   Patients of the study could not be informed and involved because we used pseudonymised

158   data. It was not possible to identify patients. The dissemination of the results will be

159   performed by publications publicly accessible.

160

161   **Results**

162   *Observed Sample*

163   The sample drawn from the AOK statutory health insurance provider dataset included

164   13,478 hospitalised patients from an overall population of 31,079 nursing home residents

165   and 560,998 hospitalised patients from an overall population of 3,841,166 AOK insured

166   persons living at home (Table 1).

167   Table 1. Observed Sample, Unadjusted hospitalisation patterns

	Patients living		
	…in Nursing Home	… not in Nursing Home	P-Value
Number of patients	31,079	3,841,166	-
Number of hospitalised patients	13,478	560,998	-
Number of admissions and readmissions	23,982	909,260	-
Hospitalisation rate (per 100 patients per year)	77.16	23.67	< 0.0001
PAHs (n, %)	6,449 (26.89%)	136,543 (15.02%)	< 0.0001
UHs (n, %)	15,647 (65.24%)	398,167 (43.79%)	< 0.0001

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169   *Description of the included population*

170   Mean age of hospitalised patients living in nursing homes was 80.58 ± 13.31 years with

171   significantly more women in this group than in the patient group living at home (68.56%

172   versus 53.64%). In comparison, the mean age of the hospitalised patients living at home

173   was 55.52 ± 24.66 years. Hospitalised nursing home patients suffered from more chronic

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174 diseases. In this study, level of care category for nursing home patients was significantly

175 higher than for patients living at home (1.82±0.76 versus 0.17 ± 0.52). HZV enrolment

176 ("family doctor coordinated care") for hospitalised nursing home patients was somewhat

177 lower than for hospitalised patients living at home (Table 2).

178

179 Table 2. Demographics of hospitalised patients

	Patients living		
	…in Nursing Home	… not in Nursing Home	P-Value
Number of Patients	13,478	560,998	-
Age (AVG ± SD)	80.58 ± 13.31	55.52 ± 24.66	< 0.0001
Gender (% female)	68.56%	53.64%	< 0.0001
Morbidity (AVG ± SD)	4.32 ± 2.76	2.23 ± 2.65	< 0.0001
Level of Care Category (AVG ± SD)	1.82 ± 0.76	0.17 ± 0.52	< 0.0001
HZV Enrolment (% participation)	31.19%	38.88%	< 0.0001

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181 *Hospitalisations patterns*

182 In total, 23,982 hospitalisations of patients living in nursing homes and 909,260

183 hospitalisations of patients living at home were evaluated for the 2015 period. This means a

184 hospitalisation rate of 77.16% versus 23.67% in the two different study groups. 15,647

185 hospitalisations of the nursing home patients were either OOHC-hospitalisations or

186 hospitalisations due to an emergency (65.24%). In comparison, 398,167 of the 909,260

187 hospitalisations of patients living at home were unplanned (43.79%). This was a significantly

188 higher proportion of UHs for nursing home residents in comparison to patients living at

189 home (Table1).

10

Comparison of Ambulatory Care Sensitive Conditions (ACSCs) of nursing home patients and patients living at home

6,449 PAHs of nursing home patients (26.9%) and 136,543 PAHs of patients living at home (15.02%) were identified. Comparing the two study populations, there was a significant increase in the relative rate (79.03%) of ACSCs in the nursing home group. The adjusted odds ratios for patients living in nursing homes were significantly higher than the patient group living at home for PAHs as for UHs (Table 3). This means the adjusted chance for a PAH was nearly 22% higher for patients living in a nursing home and the adjusted chance of UHs was more than 50% higher for patients living in a nursing home compared with patients living at home.

In addition, 90.87% of PAHs with ACSCs were not in the category of planned hospitalisations. By implication, less than 10% of PAHs were planned hospitalisations.

Table 3. Adjusted odds ratios for hospitalisation target variables. (Nursing home patients versus patients living at home)

	Odds Ratio	95%-CI	P-Value
PAHs	1.218	[1.179, 1.258]	< 0.0001
UHs	1.514	[1.470, 1.559]	< 0.0001

The top ten PAHs according to ACSC category for both groups are shown in Table 4. Pneumonia (J18), Fracture of Femur (S72), Volume depletion E86) and Epilepsy (G40) occurred noticeably more often in nursing home patients.

Table 4. Top ten PAHs according to ACSC category.

Nursing Home Patients					Non Nursing Home Patients				
Rank	ICD-10 Code	Diagnosis	n	%	Rank	ICD-10 Code	Diagnosis	n	%
1	J18	Pneumonia	1,196	18.52	1	I50	Heart failure	21,775	15.94
2	I50	Heart failure	1,137	17.61	2	F10	Disorders due to	16,204	11.86

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		Nursing Home Patients					Non Nursing Home Patients		
Rank	ICD-10 Code	Diagnosis	n	%	Rank	ICD-10 Code	Diagnosis	n	%
							use of alcohol		
3	S72	Fracture of femur	827	12.81	3	J18	Pneumonia	12,195	8.93
4	E86	Volume depletion	588	9.11	4	I20	Angina pectoris	11,474	8.40
5	G40	Epilepsy	549	8.50	5	I10	Essential (primary) hypertension	9,574	7.01
6	E11	Type 2 diabetes mellitus	332	5.14	6	S72	Fracture of femur	6,868	5.03
7	J20	Acute bronchitis	278	4.31	7	E11	Type 2 diabetes mellitus	6,262	4.58
8	K21	Gastro-oesophageal reflux disease	180	2.79	8	G40	Epilepsy	6,189	4.53
9	I10	Essential (primary) hypertension	170	2.63	9	J20	Acute bronchitis	4,654	3.41
10	K59	Other functional intestinal disorders	120	1.86	10	E86	Volume depletion	4,434	3.25

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Discussion

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214 The analysis of the AOK statutory health insurance provider dataset identified numerous

215 PAHs especially in the context of UHs (including emergency and OOHC). 23,982

216 hospitalisations of nursing home patients and 909,260 hospitalisations of patients living at

217 home occurred in 2015. Comparing the number of PAHs in both patient groups, the

218 adjusted odds ratios for PAHs were significantly higher in the NH group. More than 90% of

219 PAHs in nursing homes with ACSCs were UHs. Our study design did not allow for remarks

220 about sociodemographic data of the study population, which could perhaps influence our

221 results. In addition, information on the staffing ratio or the education of the nursing home

222 staff was not available to us. With regard to the currently increasing workforce shortages in

223 German nursing homes and the increasingly high workload of GPs, we consider that these

224 could be key factors contributing to the significantly higher PAHs in nursing homes.[6,30]

225 Our results are in accordance with several other international studies, which in particular

226 identify the need for improved continuity of care for people in nursing homes.[10,12-15,31]

227 Haber et al. showed in their study that consistency of the relationship between GP and

228 nursing home patient was an important factor of reducing PAHs and of reducing OOHC or

229 ED visits, which often result in UHs.[32] It is of great importance that the primary medical

230 practitioners (usually GPs) know the medical history of their patients who are nursing home

231 residents. This is for a number of reasons. Firstly, to ensure optimal care management of

232 patient health needs; secondly, to coordinate care between providers as well as to

233 anticipate potential deterioration of patient health conditions and finally, to therefore

234 reduce unnecessary utilisation of acute hospital services.[10,33]

235 NH patients with ACSCs who do not have a primary health care provider in regular

236 attendance will be potentially frequent attenders in OOHC and EDs.[34,35] The overcrowding

237 of OOHC centres and EDs is as well as PAHs (normally UHs) of NH patients are stretching

238 resources to the limits in health care systems of many European countries and the United

239 States of America.[36,37] Frequent attenders or patients with minor ailments are in large part

240 responsible for the high workload of physicians and staff in OOHC and EDs. Consultations of

241 these patients with perhaps minor ailments in OOHC or EDs should be avoided, except for

242 the most urgent or complex cases.[38-40] However, this is creating the need for new

243 approaches to conditions such as pneumonia, falls risk (e.g. to prevent fracture of femur),

244 volume depletion and epilepsy, which are four of the most frequent diagnoses connected

245 with PAHs in our study and common problems in nursing homes.[16,41,42]

246 There is little doubt on, a case-by-case basis, that such listed conditions may be severe

247 diseases without the possibility of being treated in an outpatient setting. But prophylactic

248 and monitoring procedures for these conditions are possible and do not seem to be too

249 complex in the first instance. However, individually tailored prophylactic and monitoring

250 procedures for nursing home residents are resource intensive in terms of both time and

251 staff and, due to resource constraints and workforce shortages, are a major cause of

252 current deficiencies in care provision.

253 Considering the increasing shortages of GPs, especially in rural areas, as well as increasing

254 shortages of appropriately trained nursing home staff, health policies and health services

255 experts have to look for innovative approaches to ease the health care services crisis

256 emerging in nursing homes. Therefore, additional measures to be pursued are that the

257 education of nursing home staff should be reviewed and improved and nursing staff should

258 be formally empowered to manage minor ailments e.g. like fever and pain in the first

259 instance. Unfortunately, government regulations in Germany currently prohibit in many

260 cases independent clinical decisions of nursing staff in nursing homes. The daily work of

261 nursing staff and medical practitioners is made difficult because of such regulations are no

262 longer in keeping with the tensions and demands in clinical practice in these settings.[43,44]

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265 In Germany, the current government has introduced a new workforce policy to address the

266 pressing problem of staff shortages and agreed to fund 8,000 new geriatric nurses

267 (*Altenpflege*) with enhanced competencies for nursing homes through the statutory health

268 insurance.[30] The policy for upskilling a segment of the geriatric nursing workforce is one

269 important step but will not bring immediate improvements to coordination of care and

270 information flow between the different providers across health care sectors. PAHs of

271 nursing home residents and effective outpatient management remain complex problems

272 that must be dealt with in parallel on many fronts.

273 The complex difficulties in improving the care of nursing home residents were shown in the

274 INTERACT-program (Interventions to reduce Acute Care Transfers) a randomised

275 prospective study. Despite training and support of the staff, the objectives of reducing

276 hospital admissions or ED visits for NH residents were not achieved.[43] Kane at al. explain the

277 lack of effectiveness are being due to a multitude of interacting factors: Quality of the NH

278 staff, lacking continuous medical care, concerns over liability and poor motivation to reduce

279 hospitalisations in nursing home patients.[43]

280 Perhaps in future service providers such as nurse practitioners, medical assistants - in

281 Germany VERAH (*Versorgungsassistentin in der Hausarztpraxis*) - palliative care teams,

282 geriatric specialist services may support primary care providers (GPs) and nursing home

283 staff in improving medical care and reducing PAHs of nursing home residents.[10,45-47]

284 However, the proven effects of these new models or interventions remains low and should

285 be studied further.[47]

286 A further initiative by the German government has been the introduction of the "Innovation

287 Fund". With this programme, health services research projects are subsidised, and this

288 includes among others, pilot projects to improve the care of nursing home residents and to

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289 reduce PAHs. It remains to be seen, if the results of these projects translate to improved

290 responsiveness to the needs of nursing home residents.[48-50]

291 Finally, the issue of remuneration needs to be addressed. High workloads, dealing with the

292 impacts of staff shortages and increasingly complex patient care requirements in the

293 primary care sector, place a burden on the existing workforce. GPs, other specialists and

294 nursing staff should also be remunerated adequately and advanced training to upskill staff

295 should be incentivised. In that respect, NHs, insurance companies and the government are

296 called upon to give financial incentives.[4,10,51,52]

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298 **Conclusions**

299 A high rate of PAHs, which may be predominantly UHs (OOHC/ED) for nursing home

300 residents could suggest that the traditional approach to health care provision in NHs needs

301 improvement. At the individual level, physicians in primary care and OOHC and the staff in

302 NHs have to be sensitised to manage common health problems of patients that too often

303 result in PAHs. There is little doubt that the management of diseases with ACSCs is a

304 complex problem. These problems need case-by-case decisions, to determine whether they

305 are best managed in outpatient or in-patient settings. We consider prerequisites for

306 improved inter-sectoral collaboration are sufficient numbers of nursing home staff,

307 upskilled with today's needed competencies and GPs/primary care medical specialists who

308 are motivated to upskill in geriatric health care. Finally, at a system level, policy makers and

309 regulators of the health professions need to use incentives and remuneration programs to

310 achieve the ambitious goals of improving nursing home care and reducing PAHs -

311 predominantly UHs - of nursing home residents.

312 **Author Contributions** GL, JS and RL initiated and designed the study. GL and RL coordinated
313 the study. GL carried out data analysis. RL, SB (native English speaker) and GL wrote the
314 manuscript. All authors (RL, SB, JS and GL) commented on the draft and approved the final
315 version of the manuscript.

320 **Competing interests** None declared

321 **Patient consent** Not required

322 **Data sharing statements** Data used in this analysis are not in the public domain an use was
323 covered by data sharing agreements with the AOK Baden-Wuerttemberg.

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Appendix

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500   Supplement 1: List of ICD 10-GM Codes Used to Identify Hospitalizations for Ambulatory

501   Care–Sensitive Conditions

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Supplement 1

Supplemental Table 1. List of ICD 10-GM Codes Used to Identify Hospitalizations for Ambulatory Care–Sensitive Conditions	
Ambulatory Care Sensitive Condition	*ICD10-GM Code*
Angina	I20, I24.0, I24.8, I24.9
Asthma	J45, J46
Cellulitis	L03, L04, L08.0, L08.8, L08.9, L88, L98.0
Congestive heart failure	I11.0, I50, J81
Convulsion and epilepsy	G40, G41, R56, O15
Chronic obstructive pulmonary disease	J20, J41, J42, J43, J47
Dehydration and gastroenteritis	E86, K52.2, K52.8, K52.9
Dental conditions	A69.0, K02, K03, K04, K05, K06, K08, K09.8, K09.9, K12, K13
Diabetes complications	E10.0–E10.8, E11.0–E11.8, E12.0–E12.8, E13.0–E13.8, E14.0– E14.8
Ear, nose and throat infections	H66, H67, J02, J03, J06, J31.2
Gangrene	R02
Hypertension	I10, I11.9
Influenza and pneumonia	J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18
Iron-deficiency anemia	D50.1, D50.8, D50.9
Nutritional deficiency	E40, E41, E42, E43, E55.0, E64.3
Other vaccine preventable diseases	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4
Pelvic inflammatory disease	N70, N73, N74
Perforated/bleeding ulcer	K25.0–K25.2, K25.4–K25.6, K26.0–K26.2, K26.4–K26.6, K27.0–K27.2, K27.4–K27.6, K280–282, K284–K286
Pyelonephritis	N10, N11, N12, N13.6
Alcohol-related diseases	F10
Atrial fibrillation and flutter	I47.1, I47.9, I49.5, I49.8, I49.9, R00.0, R002, R00.8
Constipation	K59.0
Fractured proximal femur	S72.0, S72.1, S72.2
Dyspepsia and other stomach function disorders	K30, K21
Hypokalemia	E87.6
Migraine/acute headache	G43, G44.0, G44.1, G44.3, G44.4, G44.8, R51x
ICD-10-GM = International Classification of Diseases-, 10th Revision – German Modification.	

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Please see line 1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Please see page 2 and page 3
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Please see page 4 and page 5
Objectives	3	State specific objectives, including any prespecified hypotheses Please see lines 94-98
Methods		
Study design	4	Present key elements of study design early in the paper Please see lines 100-108
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Please see lines 109-115
Participants	6	*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants Please see lines 109-115
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Please see lines 159-162 for outcomes and exposures Please see lines 151-153 for potential confounders, and effect modifiers
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Please see lines 134-146
Bias	9	Describe any efforts to address potential sources of bias Please see lines 151-153
Study size	10	Explain how the study size was arrived at Please see lines 135-136
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Please see lines 150-156

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Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		Please see lines 150-156
		(*b*) Describe any methods used to examine subgroups and interactions
		Please see lines 150-156
		(*c*) Explain how missing data were addressed
		There were no missing data
		(*d*)*Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		n. a. (full census)
		(*e*) Describe any sensitivity analyses
		n. a.

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Results

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| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed |
| | | Please see lines 174-177 |

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| | | (b) Give reasons for non-participation at each stage |
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| | | (c) Consider use of a flow diagram |
| | | Flow diagram not needed since non-complex sample finding |

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| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders |
| | | Please see lines 181-189 |

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| | | (b) Indicate number of participants with missing data for each variable of interest |
| | | There were no missing data |

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| | | *Cross-sectional study—*Report numbers of outcome events or summary measures |
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| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included |
| | | Please see lines 204-206 and lines 207-216 |

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		(*b*) Report category boundaries when continuous variables were categorized
		Age: 0-110 years
		Charlson-Index: 0-20
		Level of care: 0-5

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| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period |
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| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses |
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Discussion

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| Key results | 18 | Summarise key results with reference to study objectives |

Please see lines 226-237

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
		Please see lines 39-47 and lines 230-237
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
		Please see pages 12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results
		Please see pages 15-16

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
		Please see lines 331-332

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.