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Effect of involving highly qualified non-physician health care professionals in primary care: A cross-sectional study on quality and efficacy in 861.223 patients in Germany

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3 **1 Effect of involving highly qualified non-physician health care**
4 **2 professionals in primary care: A cross-sectional study on**
5 **3 quality and efficacy in 861.223 patients in Germany**
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10 Short title: Effect of highly qualified non-physician health care professionals in
11 primary care
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3 **1 Abstract**
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5 **2 Objectives:** Growing prevalence of chronic diseases and limited resources
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7 are key challenges for future health care. As a promising approach to
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9 maintain access to high-quality primary care, non-physician health care
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11 professionals have been trained to broaden qualifications and responsibilities.
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13 However, to date it is unclear whether this development is targeted to meet
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17 future challenges.
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19 **8 Design:** Cross-sectional study

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21 **9 Setting:** Primary care
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24 **10 Participants:** Patients insured by the AOK statutory health insurer (Baden-
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Wuerttemberg, Germany).

12 **12 Interventions:** Since 2008 practice assistants in Germany can enhance their
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14 professional education to become certified health care assistants (HCA,
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German: VERAH).

15 **15 Primary and secondary outcome measures:** Claims data related to patients
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17 treated in practices employing at least one certified HCA were compared to
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19 data from practices not employing HCAs (non-HCA) to determine frequency of
20
21 consultations, hospital admissions and readmissions. Economic analysis
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23 comprised number of uneconomic prescriptions and costs for hospitalization
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25 and outpatient medication.

21 **21 Results:** A total of 397.493 patients were treated in HCA practices, 463.730
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23 patients attended to non-HCA practices. Patients in HCA practices had an 8.2%
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25 lower rate of specialist consultations ($p < 0.0001$), a 4.0% lower rate of
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27 hospitalizations ($p < 0.0001$), a 3.5% lower rate of readmissions ($p = 0.0463$), a
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14.2% lower rate of uneconomic prescriptions and 4.7% lower costs of total

1 medication ($p < 0.0001$). No difference was found regarding the consultation rate
2 of general practitioners and hospital costs.

3 **Conclusions:** For the first time this high-volume data analysis showed that
4 involving higher qualified non-physician health care professionals in primary
5 care is associated with a reduction in hospital admissions, specialist
6 consultations and overall medication costs. Consequently, broadening
7 qualifications may be a successful strategy not only to share physicians' work
8 load but to improve quality and efficacy in primary care to meet future
9 challenges. Further studies should explore specific tasks to be shared with non-
10 physician workforces and standardization of the professional role.

1 **Strengths and limitations of this study**

- 2 • This is the first high-volume data analysis assessing the potential effect of
3 broadening qualifications and responsibilities of non-physician health care
4 professionals on quality and efficacy of primary care.
- 5 • It was possible to show that involving health care assistants (HCAs) in
6 primary care in Germany is associated with a reduced rate in hospital
7 admissions, specialist consultations and overall medication costs.
- 8 • The study indicates that broadening of qualifications of non-physician
9 health care professionals could be of high relevance for the development
10 of primary care concepts to meet future health care challenges.
- 11 • The professional role of HCAs in Germany is not fully standardized, thus
12 limitations are given to the transferability of the intervention.
- 13 • Due to the retrospective study design, potential bias and confounding
14 factors cannot be fully excluded, however, adjustments for known
15 confounders were performed for the analysis.

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3 **1 Abbreviations:**
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- 5 2 AOK statutory health insurance provider (German: Allgemeine
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7 Ortskrankenkasse)
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9 3
10 4 GP general practitioner
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12 5 HCA health care assistant
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14 6 HZV GP-centred care (German: Hausarztzentrierte Versorgung)
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16 7 PZN central pharmaceutical number (Pharmazentralnummer)
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For peer review only

1 Introduction

2 All over the globe, providing access to high-quality primary care is a challenge
3 for health care systems. In the view of growing prevalence of chronic diseases
4 and limited health care resources, physicians are confronted with increasing
5 numbers of consultations while time is very limited.

6 Particularly in times of evidence-based practice and growing use of treatment
7 algorithms, time is needed to meet patient's individual preferences or
8 circumstances, which are deciding factors for treatment success [1,2].

9 Consequently, strategies are needed to maintain access to high-quality
10 general practice. As a promising worldwide approach, highly qualified non-
11 physician health care professionals such as nurse practitioners and practice
12 nurses in the U.S. or in Australia, or primary healthcare nurse practitioners in
13 Canada, are trained to take a more active role in primary care, particularly in
14 treatment of patients with chronic diseases [3–6]. In Germany non-physician
15 staff in primary care usually consists of practice assistants, who absolved
16 professional training for three years. Since 2008 practical assistants in may
17 undergo an additional training program of 200 hours to become certified as a
18 so-called health care assistant (in German: "Versorgungsassistent/in in der
19 Hausarztpraxis", VERAH). Health care assistants (HCAs) are qualified to be
20 closer involved in primary care delivery performing tasks such as team-based
21 case management and monitoring of chronically-ill patients, routine home
22 visits, and wound care [5].

23 However, to date there is only limited knowledge about the effect of
24 broadening skills and responsibilities of non-physician workforces on quality
25 and efficacy of primary care. Recent RCTs did not find a beneficial effect of

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3 1 disease management programs led by non-physician work forces on care
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5 2 indicators like hospitalization rate or health care costs [7–9]. A recent
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7 3 Cochrane meta-analysis of 18 RCTs assessing the influence of nurses
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9 4 working as a substitute for physicians showed that nurse-led care may be
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11 5 equal in terms of health outcomes like control of diabetes and blood pressure
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13 6 and patient satisfaction [10]. However, no conclusion could be drawn with
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15 7 regard to the influence of involving nurses or other highly-qualified non-
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17 8 physician health care professionals on efficacy indicators like hospitalization
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19 9 rate, specialist consultations and costs. Furthermore, sample size planning of
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21 10 available RCTs was not adjusted for these indicators and may be
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23 11 underpowered to capture effects in this regard. For the first time this
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25 12 retrospective data analysis was intended to assess the influence of
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27 13 broadening skills and responsibilities of non-physician health care
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29 14 professionals in a high-volume setting.
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1 **Methods**

2 Study Design

3 A comparative observational study was conducted. Data related to patients
4 treated in general practices between January 1 and December 31, 2014 were
5 supplied by the AOK statutory health insurance company (AOK Baden-
6 Wuerttemberg, Germany) and used to assess the influence of involving
7 trained practice assistants in primary care delivery. The local institutional
8 Ethics Committee of the University Hospital Heidelberg had no concerns to
9 use these data without informed consent for study purposes (No. S-
10 359/2013).

11 Study population

12 Secondary data related to patients insured by the AOK statutory health
13 insurance company of Baden-Wuerttemberg, Germany, and participating in a
14 specific primary care program in Germany (GP-centred care; German:
15 "Hausarztzentrierte Versorgung" (HZV)) were eligible for data analysis. The
16 federal state of Baden-Wuerttemberg has a population of about 10.7 million
17 and AOK is the largest statutory health insurer with about 4 million insured
18 persons. The HZV program is a large-scale legally stipulated care concept
19 encouraging patients to enroll with a general practitioner (GP), aiming to
20 strengthen primary care and to enhance health care for patients with chronic
21 diseases and complex health care needs [11]. Secondary patient data were
22 included in the analysis, if patients met the following criteria: aged 18 years or
23 older, living in Baden-Wuerttemberg, at least one visit to the primary care
24 physician in the relevant year, no registration with other primary care

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3 1 contracts (e.g., integrated care contracts), no interruptions of registration to
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5 2 HZV program in the relevant year.

3 Intervention

4 Since 2008, practice assistants working in practices participating in the HZV
5 program in Germany, can enhance their professional education by attending a
6 standardized curriculum of 200 teaching units of theoretical and practical
7 lessons. Upon examination, these practice assistants become certified as
8 HCA (German: VERAH) [5]. Besides routine tasks like blood sampling, ECGs
9 or spirometries, HCAs are thought to perform monitoring of chronically-ill
10 patients, prevention measures, routine home visits and wound care
11 management.

12 Data acquisition and outcome parameters

13 Secondary patient data were recorded by the AOK state health insurance
14 company for reimbursement purposes and continuous evaluation of the HZV
15 program. For the analysis, data were supplied by the AOK to the Department
16 of General Practice and Health Services Research, University Hospital
17 Heidelberg. Subjects cannot be identified, directly or through identifiers linked
18 to the subjects. Data storage and extraction were performed with MySQL
19 Community Server x64 (Oracle Corporation, Redwood Shores, CA, USA). All
20 national and institutional guidelines concerning data acquisition for
21 retrospective analyses were followed at all times.

22 The obtained data set comprised age, gender, diagnoses according to ICD-10
23 coding as well as accounting data on consultations, prescribed medication and
24 hospital stays. The Charlson index was determined according to ICD-10
25 documentation in order to approximate patients' overall morbidity. Diagnoses

1 of chronic conditions were assigned to values between 1 and 6 according to
2 severity. Finally, a sum score was determined for each patient. The underlying
3 calculus is described in detail elsewhere [12]. The number of patient contacts
4 to GP could be determined by the codes according to the EBM system
5 (“Einheitlicher Bewertungsmaßstab”) used for accounting of outpatient medical
6 services in Germany. Outpatient medication costs in € and the number of
7 prescription so-called me-too drugs, patent-secured marginally altered
8 pharmaceuticals with no benefit compared to the prototype drug according to
9 evidence-based criteria [13], was be determined using records of the central
10 pharmaceutical numbers of prescribed medications (“Pharmazentralnummer”,
11 PZN). Number of hospital admissions, readmissions within 4 weeks and costs
12 for hospitalization in € was determined by the recorded Diagnosis Related
13 Groups (DRG) codes used for reimbursement of inpatient medical services in
14 Germany.

15 Statistical analysis

16 In order to calculate frequencies, rates and percentages, we used SAS PROC
17 SQL. In order to assess the adjusted outcomes of interest, we used SAS
18 PROC GENMOD (SAS V.9.4×64, SAS Institute). The following factors were
19 selected ex ante for the adjustment of the comparison between groups:
20 patient age, sex, Charlson index [12], nursing home as residence, nursing
21 care level (legally defined 4-point scale to assess need for nursing support),
22 urbanization (rural, urban), practice size (number of contacts in relevant
23 period), type of practice (single, group). For all analyses, results were
24 considered statistically significant, if the p value was 0.05 or less.

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3 1 Patient and public involvement
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5 2 Exploring strategies to provide and maintain access to high-quality primary
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7 3 care is of public interest, particularly in the view of growing prevalence of
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9 4 chronic diseases and limited health care resources. Due to the retrospective
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11 5 study design based on an analysis of pseudonymized data, patients could not
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13 6 be identified, nor be informed or involved into this study. The public
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15 7 dissemination of the results is intended to be achieved by scientific
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17 8 publication.
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1 Results

2 861.223 patients were evaluated in the observation period from January 1 to
 3 December 31, 2014. 397.493 patients were treated in practices involving at
 4 least one HCA to primary care (HCA group), 463.730 patients were seen in
 5 practices, which did not employ HCAs (non-HCA group). Patients
 6 characteristics are shown in Table 1.

Table 1: Patient characteristics

	HCA	Non-HCA	p
Number of patients	397493	463730	
Male (N, %)	174415 (43.9%)	200775 (43.2%)	<0.0001
Age	56.9 ± 18.5	58.4 ± 18.1	<0.0001
Charlson Index	1.37 ± 2.0	1.38 ± 1.98	<0.0001
Care level [N]			<0.0001
No care:	378919	442024	
I:	11186	13165	
II:	5771	6765	
III:	1593	1751	
IV:	24	25	

Continuous values are presented as mean ± standard deviation; HCA: health care assistant;

7
 8 According to the adjusted analysis patients in the HCA-group had an 8.2%
 9 lower rate of specialist consultations ($p < 0.0001$). Per-patient number of
 10 hospitalizations was 4.0% lower ($p < 0.0001$) and number of readmissions was
 11 3.5% lower in the HCA group ($p = 0.0463$). Prescriptions of non-generic
 12 medication were 14.2% lower and total medication costs for outpatient care was
 13 4.69% lower in the HCA-group respectively ($p < 0.0001$). No difference was
 14 found with regarding the number of GP consultations and costs of
 15 hospitalization (Table 2).

16 Table 2: Outcomes

Parameter	Unadjusted Outcome		Adjusted Difference (AD) HCA vs. non-HCA		
	HCA	Non-HCA	AD [95%CI]	AD in %	p
GP consultations	13.46 ± 11.42	13.72 ± 11.81	-0.063 ± 0.021 [-0.105, -0.022]	-0.21%	0.0028
Specialist consultations	4.59 ± 8.23	4.89 ± 8.38	-0.209 ± 0.018 [-0.245, 0.173]	-8.21%	<0.0001
Hospitalization	0.272 ± 0.762	0.286 ± 0.790	-0.013 ± 0.008 [-0.057, -0.025]	-4.00%	<0.0001
Readmissions	0.210 ± 0.682	0.216 ± 0.721	-0.036 ± 0.018 [-0.071, -0.006]	-3.53%	0.0463
Costs of hospitalization [€]	6,239 ± 9,388	6319 ± 9278	-40.42 ± 0.005 [-0.018, 0.003]	0.73%	0.1711
Avoidable prescriptions	3.12 ± 10.15	3.57 ± 10.89	-0.388 ± 0.026 [-0.437, -0.334]	-14.2%	<0.0001
Outpatient medication costs [€]	1,333 ± 59,877	1376 ± 51567	-71.01 ± 0.011 [-0.070, -0.026]	4.69%	<0.0001

Values are presented as mean ± standard deviation; AD: adjusted difference; GP: general practitioner;

HCA: health care assistant; CI: confidence interval

1 Discussion

2 For the first time, this retrospective data analysis assessed the influence of
3 enhancing qualifications and responsibilities of non-physician health care
4 professionals on quality and efficacy of primary care in a high volume setting.
5 The analysis of care-related data of 861.223 patients showed a lower rate of
6 hospitalizations, specialist consultations as well as lower overall medication
7 costs when HCAs were part of the practice staff. Although the measured
8 effect is low-scaled, it is of high relevance for the development of future
9 primary care concepts. From a patient-centered view avoiding hospitalization
10 or unnecessary medication may help to reduce patients' burden and morbidity
11 due to hospital stay or pharmacological side-effects. On the other hand,
12 avoidable treatment will be not only a central determinant of quality, but a key
13 cost factor for health care systems, which will be challenged by the rising
14 prevalence of chronic diseases in the future.

15 The measured effect may be hypothesized to be due to an improved patient
16 access to primary care. Either directly by attending to higher qualified practice
17 assistants or indirectly by improvement of workflow, patients may benefit from
18 a higher quality and efficacy of care. Hospitalizations and specialist
19 consultations may be avoided by a more intensive outpatient care.
20 Particularly, patients with chronic diseases may benefit from extended
21 services like intense monitoring, education and reminders. And eventually,
22 costs for prescriptions may be reduced by efficient management of medication
23 regimen.

24 To date, knowledge about potential effects of involving higher qualified non-
25 physician healthcare professionals in primary care is low. Several RCTs

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3 1 evaluating disease management programs for chronic conditions like chronic
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5 2 pulmonary disease or heart failure involved such practice assistants, however,
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7 3 did not prove an effect on relevant care indicators [4,8,14]. A potential reason
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9 4 for this contrast to our findings may be an underpowered sample-size
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11 5 postulating a reduction of avoidable hospitalizations up to 20%. For
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13 6 comparison, a recent meta-analysis of 12 RCTs evaluating complex
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15 7 multidisciplinary disease management programs involving medical care by
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17 8 specialist physicians for heart failure patients found a considerably lower
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19 9 scaled effect size, showing a reduction of 8% in all-cause hospitalization,
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21 10 which is closer to the effect measured in this present study [15].
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24 11 Another relevant finding of this study is that the rate of GP consultations was
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26 12 only slightly reduced by 0.21% when HCAs were involved. This is noteworthy,
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28 13 since one may expect that HCAs may perform chosen routine tasks
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30 14 independently. On the other hand, this result may reflect that involvement of
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32 15 HCAs is not implemented as a one-way delegation or as a substitution for
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34 16 physician care like it has been proposed for nurse-led care concepts [10], but
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36 17 more as a team interaction possibly generating a more efficient and high-
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38 18 quality work flow. However, the specific influence of involving HCAs is difficult
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40 19 to determine, since in Germany there is no firmly standardized professional
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42 20 role. A recent survey showed that tasks performed by HCAs differ widely
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44 21 from simple patient assessment or basic wound care to tasks with substantial
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46 22 responsibility like emergency home visits, chronic care management or
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48 23 treatment of complex wounds [5]. Eventually, the GP decides which tasks are
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50 24 performed by HCAs and how far they perform them independently. While this
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52 25 approach meets individual eligibility, more standardization may be favorable
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1 to identify tasks to be shared in team according to their effect on care quality
2 and efficacy. Furthermore it could help to reveal potential limitations, like e.g.
3 it has been found in nurse-led self-management programs of COPD, which
4 have been associated with higher airway-related mortality [8,16]. A promising
5 approach for a standardized involvement of HCAs certainly lies in chronic
6 disease management programs, which proved to be efficient for heart failure
7 or asthma bronchiale [15,17,18]. New IT-based methods such as web-based
8 telemedical care, which has been shown to prevent hospital admissions and
9 reduce all-cause mortality in heart failure patients, should also be considered
10 [19]. Finally, standardized translational approaches after hospital release are
11 promising to reduce hospitalization rates and improve quality of life, like it has
12 been shown in COPD patients recently [20].

13 To our knowledge this high-volume secondary data analysis is the first study
14 indicating that involvement of highly qualified non-physician health care
15 professionals to primary care has a beneficial effect the rate of hospital
16 admissions, specialist consultations and overall medication costs. Limitations
17 are given by the retrospective study design and associated risk of bias.
18 However, potential confounding factors such as patients' morbidity and type
19 and size of included practices were considered for the adjustment of the
20 intervention effect. Another limitation may be given by the transferability, since
21 the role of HCAs is not firmly standardized and therefore no recommendations
22 can be given regarding the specific tasks, which may be performed by higher
23 qualified medical workforces. Furthermore, evaluation of relevant patient-
24 related outcome parameters such as quality of life was not possible in this
25 analysis. These aspects may be addressed by further prospective studies.

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3 1 As a conclusion, this high-volume retrospective data analysis showed that
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5 2 involving highly qualified non-physician health care professionals in primary
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7 3 care is associated with a reduction in hospital admissions, specialist
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9 4 consultations and overall medication costs. Consequently, this may be a
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11 5 successful strategy not only to share physicians' work load but to improve
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13 6 quality and efficacy of primary care to meet future health care challenges.
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15 7 Further studies should explore specific tasks to be shared with non-physician
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17 8 workforces and standardization of the professional role.
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Contributors

3 Jonas D. Senft: design and methods, writing the article; Regina Poss-Doering:
4 revision of the article; Michel Wensing: revision of the article; Joachim
5 Szecsenyi: design and methods, revision of the article; Gunter Laux: design
6 and methods, statistical analysis, revision of the article. All authors commented
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Competing interests

8 The authors Jonas D. Senft, Regina Poss-Doering, Michel Wensing, Joachim
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Data sharing statement

15 Data used in this analysis are not in the public domain and use is covered by
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References:

1. Zolnierek KBH, Dimatteo MR. Physician communication and patient adherence to treatment: a meta-analysis. *Med Care*. 2009;47: 826–834. doi:10.1097/MLR.0b013e31819a5acc
2. Kelley JM, Kraft-Todd G, Schapira L, Kossowsky J, Riess H. The influence of the patient-clinician relationship on healthcare outcomes: a systematic review and meta-analysis of randomized controlled trials. *PLoS ONE*. 2014;9: e94207. doi:10.1371/journal.pone.0094207
3. Ghorob A, Bodenheimer T. Sharing the care to improve access to primary care. *N Engl J Med*. 2012;366: 1955–1957. doi:10.1056/NEJMp1202775
4. Freund T, Peters-Klimm F, Boyd CM, Mahler C, Gensichen J, Erler A, et al. Medical Assistant-Based Care Management for High-Risk Patients in Small Primary Care Practices: A Cluster Randomized Clinical Trial. *Ann Intern Med*. 2016;164: 323–330. doi:10.7326/M14-2403
5. Mergenthal K, Beyer M, Gerlach FM, Guethlin C. Sharing Responsibilities within the General Practice Team - A Cross-Sectional Study of Task Delegation in Germany. *PLoS ONE*. 2016;11: e0157248. doi:10.1371/journal.pone.0157248
6. Freund T, Everett C, Griffiths P, Hudon C, Naccarella L, Laurant M. Skill mix, roles and remuneration in the primary care workforce: who are the healthcare professionals in the primary care teams across the world? *Int J Nurs Stud*. 2015;52: 727–743. doi:10.1016/j.ijnurstu.2014.11.014
7. Bekelman DB, Plomondon ME, Carey EP, Sullivan MD, Nelson KM, Hattler B, et al. Primary Results of the Patient-Centered Disease Management (PCDM) for Heart Failure Study: A Randomized Clinical Trial. *JAMA Intern Med*. 2015;175: 725–732. doi:10.1001/jamainternmed.2015.0315
8. Fan VS, Gaziano JM, Lew R, Bourbeau J, Adams SG, Leatherman S, et al. A comprehensive care management program to prevent chronic obstructive pulmonary disease hospitalizations: a randomized, controlled trial. *Ann Intern Med*. 2012;156: 673–683. doi:10.7326/0003-4819-156-10-201205150-00003
9. Connor KI, Cheng EM, Barry F, Siebens HC, Lee ML, Ganz DA, et al. Randomized trial of care management to improve Parkinson disease care quality. *Neurology*. 2019;92: e1831–e1842. doi:10.1212/WNL.0000000000007324
10. Laurant M, van der Biezen M, Wijers N, Watananirun K, Kontopantelis E, van Vught AJ. Nurses as substitutes for doctors in primary care. *Cochrane Database Syst Rev*. 2018;7: CD001271. doi:10.1002/14651858.CD001271.pub3

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3 1 11. Laux G, Kaufmann-Kolle P, Bauer E, Goetz K, Stock C, Szecsenyi J.
4 2 [Evaluation of family doctor centred medical care based on AOK routine
5 3 data in Baden-Württemberg]. *Z Evid Fortbild Qual Gesundheitswes.*
6 4 2013;107: 372–378. doi:10.1016/j.zefq.2013.07.001
7
8
9 5 12. Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA.
10 6 New ICD-10 version of the Charlson comorbidity index predicted in-
11 7 hospital mortality. *J Clin Epidemiol.* 2004;57: 1288–1294.
12 8 doi:10.1016/j.jclinepi.2004.03.012
13
14 9 13. Fricke U, Hein L, Schwabe U. *Neue Arzneimittel 2016*. In: Schwabe U,
15 10 Paffrath D, Ludwig W-D, Klauber J, editors. *Arzneiverordnungs-Report*
16 11 2017. Berlin, Heidelberg: Springer Berlin Heidelberg; 2017. pp. 55–135.
17 12 doi:10.1007/978-3-662-54630-7_3
18
19
20 13 14. Siebenhofer A, Ulrich L-R, Mergenthal K, Berghold A, Pregartner G,
21 14 Kemperdick B, et al. Primary care management for patients receiving
22 15 long-term antithrombotic treatment: A cluster-randomized controlled trial.
23 16 *PLoS ONE.* 2019;14: e0209366. doi:10.1371/journal.pone.0209366
24
25 17 15. Takeda A, Martin N, Taylor RS, Taylor SJ. Disease management
26 18 interventions for heart failure. *Cochrane Database Syst Rev.* 2019;1:
27 19 CD002752. doi:10.1002/14651858.CD002752.pub4
28
29
30 20 16. Lenferink A, Brusse-Keizer M, van der Valk PD, Frith PA, Zwerink M,
31 21 Monninkhof EM, et al. Self-management interventions including action
32 22 plans for exacerbations versus usual care in patients with chronic
33 23 obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2017;8:
34 24 CD011682. doi:10.1002/14651858.CD011682.pub2
35
36
37 25 17. Smith SM, Soubhi H, Fortin M, Hudon C, O'Dowd T. Interventions for
38 26 improving outcomes in patients with multimorbidity in primary care and
39 27 community settings. *Cochrane Database Syst Rev.* 2012; CD006560.
40 28 doi:10.1002/14651858.CD006560.pub2
41
42
43 29 18. Peytremann-Bridevaux I, Arditi C, Gex G, Bridevaux P-O, Burnand B.
44 30 Chronic disease management programmes for adults with asthma.
45 31 *Cochrane Database Syst Rev.* 2015; CD007988.
46 32 doi:10.1002/14651858.CD007988.pub2
47
48 33 19. Koehler F, Koehler K, Deckwart O, Prescher S, Wegscheider K, Kirwan B-
49 34 A, et al. Efficacy of telemedical interventional management in patients with
50 35 heart failure (TIM-HF2): a randomised, controlled, parallel-group,
51 36 unmasked trial. *Lancet.* 2018;392: 1047–1057. doi:10.1016/S0140-
52 37 6736(18)31880-4
53
54
55 38 20. Aboumatar H, Naqibuddin M, Chung S, Chaudhry H, Kim SW, Saunders
56 39 J, et al. Effect of a Program Combining Transitional Care and Long-term
57 40 Self-management Support on Outcomes of Hospitalized Patients With

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1 Chronic Obstructive Pulmonary Disease: A Randomized Clinical Trial.
2 JAMA. 2018;320: 2335–2343. doi:10.1001/jama.2018.17933

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
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	9
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	n/a
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(e) Describe any sensitivity analyses	10
Results			

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	11
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	12
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	12
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
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	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	17

*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.

BMJ Open

Effect of involving certified health care assistants in primary care in Germany: A cross-sectional study on quality and effectiveness in 861,223 patients

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Manuscripts

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3 1 **Effect of involving certified health care assistants in primary**
4 **care in Germany: A cross-sectional study on quality and**
5 **effectiveness in 861,223 patients**
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10 4 Short title: Effect of involving certified health care assistants in primary care in
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12 5 Germany
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3 **1 Abstract**
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5 **2 Objectives:** Growing prevalence of chronic diseases and limited resources are
6
7 key challenges for future health care. As a promising approach to maintain
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9 access to high-quality primary care, non-physician health care professionals
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11 have been trained to broaden qualifications and responsibilities. However, to
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13 date it is unclear whether this development is targeted to meet future
14
15 challenges.
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19 **8 Design:** Cross-sectional study
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21 **9 Setting:** Primary care
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24 **10 Participants:** Patients insured by the AOK statutory health insurer (Allgemeine
25
26 Ortskrankenkasse, Baden-Wuerttemberg, Germany).
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28 **12 Interventions:** Since 2008 practice assistants in Germany can enhance their
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30 professional education to become certified health care assistants (HCA,
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32 German: VERAH).
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35 **15 Primary and secondary outcome measures:** Claims data related to patients
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37 treated in practices employing at least one HCA were compared to data from
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39 practices not employing HCAs (non-HCA) to determine frequency of
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41 consultations, hospital admissions and readmissions. Economic analysis
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43 comprised hospitalization costs, prescriptions of follow-on drugs and outpatient
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45 medication costs.
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49 **21 Results:** A total of 397,493 patients were treated in HCA practices, 463,730
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51 patients attended to non-HCA practices. Patients in HCA practices had an 8.2%
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53 lower rate of specialist consultations ($p<0.0001$), a 4.0% lower rate of
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55 hospitalizations ($p<0.0001$), a 3.5% lower rate of readmissions ($p=0.0463$), a
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57 14.2% lower rate of follow-on drug prescriptions ($p<0.0001$) and 4.7% lower
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1 costs of total medication ($p < 0.0001$). No difference was found regarding the
2 consultation rate of general practitioners and hospital costs.

3 **Conclusions:** For the first time this high-volume data analysis showed that
4 involving higher qualified non-physician health care professionals in primary
5 care is associated with a reduction in hospital admissions, specialist
6 consultations and overall medication costs. Consequently, broadening
7 qualifications may be a successful strategy not only to share physicians' work
8 load but to improve quality and efficacy in primary care to meet future
9 challenges. Further studies should explore specific tasks to be shared with non-
10 physician workforces and standardization of the professional role.

1 **Strengths and limitations of this study**

- 2 • This is the first high-volume data analysis assessing the effect of broadening
3 qualifications of non-physician workforces on quality and efficacy health
4 care indicators.
- 5 • The analysis is performed on a comprehensive sample of data of one year
6 covering 861,223 patients.
- 7 • Statistical adjustment was possible for relevant patient-sided factors like
8 patients' age and morbidity, nursing care level and structural factors like
9 practice size, urbanization and type (single or group practice).
- 10 • Due to the limitations given by the nature of claims data further potentially
11 relevant factors like educational level and experience of the staff were not
12 available for this analysis.
- 13 • The professional role of HCAs in Germany is not standardized, thus
14 limitations are given to the transferability of the intervention.

1
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3 **1 Abbreviations:**
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6 2 AOK statutory health insurance provider (German: Allgemeine
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8 3 Ortskrankenkasse)
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10 4 GP general practitioner
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12 5 HCA health care assistant
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14 6 HZV GP-centred care (German: Hausarztzentrierte Versorgung)
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16 7 PZN central pharmaceutical number (Pharmazentralnummer)
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1 Introduction

2 All over the globe, providing access to high-quality primary care is a challenge
3 for health care systems. In the view of growing prevalence of chronic diseases
4 and limited health care resources, physicians are confronted with increasing
5 numbers of consultations while time is very limited [1,2].

6 Particularly in times of evidence-based practice and growing use of treatment
7 algorithms, time is needed to meet patient's individual preferences or
8 circumstances, which are deciding factors for treatment success [3,4].

9 Consequently, strategies are needed to maintain access to high-quality general
10 practice. As a promising worldwide approach, highly qualified non-physician
11 health care professionals such as practice nurses in the U.S. or in Australia are
12 trained to take a more active role in primary care, particularly in treatment of
13 patients with chronic diseases [5–8]. For primary healthcare registered nurses
14 or nurse practitioners in Canada, there is growing evidence that their
15 involvement in practices is associated with health promotion, particularly in the
16 management of chronic diseases [9–11].

17 While qualified nurses are well integrated in primary care in other countries, in
18 Germany so far there is no professional role for nurses in general medicine. On
19 the other hand, non-academic workforces like practice or medical assistants
20 have become increasingly involved into active patient care as they have been
21 integrated into treatment monitoring or patient coaching for chronic diseases
22 like diabetes e.g. in the United States [8,12,13]. In Germany, general
23 practitioners (GP) usually employ certified practice assistants, who absolved
24 professional training for three years and traditionally performed clerical duties
25 like reception and routine tasks, such as blood sampling or electrocardiogram

1 recording. Since 2008 practical assistants may undergo an additional training
2 program of 200 hours to become certified as a so-called health care assistant
3 (German: "Versorgungsassistent/in in der Hausarztpraxis", VERAH). Health
4 care assistants (HCAs) are qualified to be closer involved in primary care
5 delivery performing tasks such as team-based case management and
6 monitoring of chronically-ill patients, routine home visits, and wound care [7].
7 However, to date there is only limited knowledge about the effect of broadening
8 skills and responsibilities of non-physician workforces on quality and efficacy of
9 primary care. Recent RCTs did not find a beneficial effect of disease
10 management programs led by non-physician work forces on care indicators like
11 hospitalization rate or health care costs [14–16]. A recent meta-analysis of 18
12 RCTs assessing the influence of nurses working as a substitute for physicians
13 showed that nurse-led care may be equal in terms of health outcomes like
14 control of diabetes and blood pressure and patient satisfaction [17].
15 However, no evidence-based conclusion can be drawn currently with regard to
16 the influence of involving higher qualified non-physician workforce on health
17 care efficacy indicators like hospitalization rate, specialist consultations and
18 costs. Furthermore, common sample sizes of available RCTs may be
19 underpowered to capture effects in this regard. The aim of this study was to
20 assess the influence of involving certified health care assistants on quality and
21 efficacy of primary care in Germany. For this purpose, for the first time a high-
22 volume claims data cross-sectional study was performed.

1 **Methods**

2 Study Design

3 A cross-sectional study was conducted. Claims data related to patients treated
4 in general practices between January 1 and December 31, 2014 were supplied
5 by the AOK statutory health insurance company (German: "Allgemeine
6 Ortskrankenkasse", Baden-Wuerttemberg, Germany). Data of patients treated
7 in practices employing at least one certified HCA were compared to data from
8 practices not employing HCAs (non-HCA) to assess the influence of involving
9 HCAs in primary care delivery. Ethical approval for this study was given by the
10 local institutional Ethics Committee of the University Hospital Heidelberg (No.
11 S-359/2013).

12 Study population

13 Secondary data related to patients insured by the AOK statutory health
14 insurance company of Baden-Wuerttemberg, Germany, and participating in a
15 specific primary care program in Germany (GP-centred care; German:
16 "Hausarztzentrierte Versorgung" (HZV)) were eligible for data analysis. The
17 federal state of Baden-Wuerttemberg has a population of about 10.7 million and
18 AOK is the largest statutory health insurer with about 4 million insured persons.
19 The HZV program is a large-scale, legally stipulated care concept encouraging
20 patients to enroll with a general practitioner (GP), aiming to strengthen primary
21 care and to enhance health care for patients with chronic diseases and complex
22 health care needs [18]. Secondary patient data were included in the analysis, if
23 patients met the following criteria: aged 18 years or older, living in Baden-
24 Wuerttemberg, at least one visit to the primary care physician in the relevant

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3 1 year, no registration with other primary care contracts (e.g., integrated care
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5 2 contracts), no interruptions of registration to HZV program in the relevant year.

3 Intervention

4 Since 2008, practice assistants working in practices participating in the HZV
5 program in Germany, can enhance their professional education by attending a
6 standardized curriculum of 200 teaching units of theoretical and practical
7 lessons. Upon mandatory examination, these practice assistants become state-
8 certified as HCA (German: VERAH) [7]. Besides routine tasks like blood
9 sampling, electrocardiogram recording or spirometry, HCAs are thought to
10 perform monitoring of chronically-ill patients, prevention measures, routine
11 home visits and wound care management.

12 Data acquisition and outcome parameters

13 Secondary patient data were recorded by the AOK state health insurance
14 company for reimbursement purposes and continuous evaluation of the HZV
15 program. For the analysis, data were supplied by the AOK to the Department
16 of General Practice and Health Services Research, University Hospital
17 Heidelberg. Practices employing certified HCAs could be unambiguously
18 identified since employment of HCAs is obligatorily reimbursed by state health
19 insurance in the HZV program. The claims data consisted of several data sets,
20 containing particular information on patient care (e. g. GP consultations,
21 prescriptions and hospitalizations). These data could be linked on the basis of
22 a unique patient identifier. Data linkage was performed by our research team
23 using a relational database. Subjects cannot be identified, directly or through
24 identifiers linked to the subjects. Data storage and extraction were performed
25 with MySQL Community Server x64 (Oracle Corporation, Redwood Shores,

1 CA, USA). All national and institutional guidelines concerning data acquisition
2 for retrospective analyses were followed at all times.

3 The obtained data set comprised age, gender, diagnoses according to ICD-10
4 coding as well as accounting data on consultations, prescribed medication and
5 hospital stays.

6 To assess the effect of involving HCAs on quality and efficacy of primary care,
7 the following outcome parameters were analyzed: GP consultations, specialist
8 consultations, hospital admissions, hospital readmissions within 4 weeks,
9 hospitalization costs, prescription of follow-on drugs and outpatient medication
10 costs. The number of GP and specialist consultations per patient could be
11 determined by the codes according to the EBM system (“Einheitlicher
12 Bewertungsmaßstab”) used for accounting of outpatient medical services in
13 Germany. Number of hospital admissions and readmissions per patient as well
14 as per-patient costs for hospitalization in € was determined by the recorded
15 Diagnosis Related Groups (DRG) codes used for reimbursement of inpatient
16 medical services in Germany. The per-patient number of prescriptions of so-
17 called follow-on drugs, patent-secured marginally altered pharmaceuticals with
18 no benefit compared to the prototype drug according to evidence-based criteria
19 [19], was determined by records of the central pharmaceutical numbers of
20 prescribed medications (“Pharmazentralnummer”, PZN). Outpatient medication
21 costs per patient in € could be determined by accounting data for prescriptions
22 reimbursed by the AOK state health insurance.

23 Statistical analysis

24 The full sample of available claims data was used for the analysis. In order to
25 calculate frequencies, rates and percentages, we used SAS PROC SQL. In

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3 1 order to assess the adjusted outcomes of interest, we used SAS PROC
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5 2 GENMOD (SAS V.9.4×64, SAS Institute). The following factors were selected
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7 3 ex ante for the adjustment of the comparison between groups: patient age, sex,
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9 4 morbidity according to Charlson Index [20], nursing home as residence, nursing
10
11 5 care level (legally defined 4-point scale to assess need for nursing support),
12
13 6 urbanization (rural, urban), practice size (number of contacts in relevant
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15 7 period), type of practice (single, group). Comparison between groups was done
16
17 8 by multivariable regression analysis, which the three-level clustering of
18
19 9 patients, GPs and practices into account. Depending on the distribution of each
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21 10 outcome, linear regression, negative-binomial regression or Poisson
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23 11 regression models (for count data) were used. For all analyses, results were
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25 12 considered statistically significant, if the p value was 0.05 or less.

30 13 Patient and public involvement

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32 14 Exploring strategies to provide and maintain access to high-quality primary care
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34 15 is of public interest, particularly in the view of growing prevalence of chronic
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36 16 diseases and limited health care resources. Due to the retrospective study
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38 17 design based on an analysis of pseudonymized data, patients could not be
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40 18 identified, nor be informed or involved into this study. The public dissemination
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42 19 of the results is intended to be achieved by scientific publication.
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1 Results

2 861,223 patients were evaluated in the observation period from January 1 to
3 December 31, 2014. 397,493 patients were treated in practices involving at
4 least one HCA to primary care (HCA group), 463,730 patients were seen in
5 practices, which did not employ HCAs (non-HCA group). Patients
6 characteristics are shown in Table 1.

Table 1: Patient characteristics: Data of patients treated in practices employing at least one HCA compared to practices not employing HCAs (non-HCA)

	HCA	Non-HCA	p
Number of patients	397493	463730	
Male (N, %)	174415 (43.9%)	200775 (43.2%)	<0.0001
Age	56.9 ± 18.5	58.4 ± 18.1	<0.0001
Charlson Index	1.37 ± 2.0	1.38 ± 1.98	<0.0001
Care level [N]			<0.0001
No care:	378919	442024	
I:	11186	13165	
II:	5771	6765	
III:	1593	1751	
IV:	24	25	

Continuous values are presented as mean ± standard deviation; HCA: health care assistant;

7 According to the adjusted analysis patients in the HCA-group had an 8.2%
8 lower rate of specialist consultations ($p < 0.0001$). Per-patient number of hospital
9 admissions was 4.0% lower ($p < 0.0001$) and number of hospital readmissions
10 was 3.5% lower in the HCA group ($p = 0.0463$). Prescriptions of follow-on drugs
11 were 14.2% lower and total outpatient medication costs were 4.69% lower in
12 the HCA-group respectively ($p < 0.0001$). No difference was found with
13 regarding the number of GP consultations and hospitalization costs (Table 2).

Table 2: Outcomes: Outcome parameters for patients treated in practices employing at least one HCA compared to practices not employing HCAs (non-HCA)

Per-patient outcome	Unadjusted Outcome		Adjusted Difference (AD) HCA vs. non-HCA		
	HCA	Non-HCA	AD [95%CI]	AD in %	p
GP consultations	13.46 ± 11.42	13.72 ± 11.81	-0.063 ± 0.021 [-0.105, -0.022]	-0.21%	0.0028
Specialist consultations	4.59 ± 8.23	4.89 ± 8.38	-0.209 ± 0.018 [-0.245, 0.173]	-8.21%	<0.0001
Hospital admissions	0.272 ± 0.762	0.286 ± 0.790	-0.013 ± 0.008 [-0.057, -0.025]	-4.00%	<0.0001
Hospital readmissions	0.210 ± 0.682	0.216 ± 0.721	-0.036 ± 0.018 [-0.071, -0.006]	-3.53%	0.0463
Hospitalization costs [€]	6,239 ± 9,388	6319 ± 9278	-40.42 ± 0.005 [-0.018, 0.003]	0.73%	0.1711
Prescription of follow-on drugs	3.12 ± 10.15	3.57 ± 10.89	-0.388 ± 0.026 [-0.437, -0.334]	-14.2%	<0.0001
Outpatient medication costs [€]	1,333 ± 59,877	1376 ± 51567	-71.01 ± 0.011 [-0.070, -0.026]	4.69%	<0.0001

Values are presented as mean ± standard deviation; AD: adjusted difference; GP: general practitioner;

HCA: health care assistant; CI: confidence interval

1 Discussion

2 For the first time, this cross-sectional study assessed high-volume claims data
3 to evaluate the influence of enhancing qualifications and responsibilities of non-
4 physician health care professionals on quality and efficacy of primary care. The
5 analysis of care-related data of 861,223 patients showed a lower rate of hospital
6 admissions, specialist consultations as well as lower outpatient medication
7 costs when HCAs were part of the practice staff. Although the measured effect
8 is low-scaled, it is of high relevance for the development of future primary care
9 concepts. From a patient-centered view, avoiding hospitalization or
10 unnecessary medication may help to reduce patients' burden and morbidity due
11 to hospital stay or pharmacological side-effects. On the other hand, avoidable
12 treatment will be not only a central determinant of quality, but a key cost factor
13 for health care systems, which will be challenged by the rising prevalence of
14 chronic diseases in the future.

15 The measured effect may be hypothesized to be due to an improved patient
16 access to primary care. Either directly by attending to higher qualified practice
17 assistants, or indirectly by improvement of workflow, patients may benefit from
18 a higher quality and efficacy of care. Hospitalizations and specialist
19 consultations may be avoided by a more intensive outpatient care. Particularly,
20 patients with chronic diseases may benefit from extended services like intense
21 monitoring, education and reminders [21]. And eventually, costs for
22 prescriptions may be reduced by efficient management of medication regimen.
23 To date, knowledge about potential effects of involving higher qualified non-
24 physician healthcare professionals in primary care is low. Several RCTs
25 evaluating disease management programs for chronic conditions like chronic

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3 1 pulmonary disease or heart failure involved such practice assistants, however,
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5 2 did not prove an effect on relevant care indicators [6,15,22]. A potential reason
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7 3 for this contrast to our findings may be an underpowered sample-size
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9 4 postulating a reduction of avoidable hospitalizations up to 20%. The results of
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11 5 our study show a much smaller effect with a reduction of 4% hospitalizations
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13 6 when HCAs were involved, which in our opinion is closer to reality in primary
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15 7 care. As a comparison, even in settings of complex disease management
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17 8 programs for heart failure patients performed by highly educated non-physician
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19 9 work force and specialist involvement, low rates of reduction in all-cause
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21 10 hospitalization are common, with a range of up to 8% as a recent meta-analysis
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23 11 of 12 RCTs showed [23].

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28 12 Another relevant finding of this study is that the rate of GP consultations was
29
30 13 only slightly reduced by 0.21% when HCAs were involved. This is noteworthy,
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32 14 since a distinct reduction of GP consultations might have been expected
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34 15 assuming that HCAs perform chosen routine tasks independently. One the
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36 16 other hand, this result may reflect that involvement of HCAs is not implemented
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38 17 as a one-way delegation or as a substitution for physician care as has been
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40 18 proposed for nurse-led care concepts [17], but more as a team interaction.
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42 19 However, no conclusion can be drawn by this study with regard to the specific
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44 20 role of HCAs within the practice staff. As a recent survey showed, in Germany
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46 21 there is no firmly standardized professional role for HCAs. Performed tasks
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48 22 differ widely from simple patient assessment or basic wound care to tasks with
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50 23 substantial responsibility like emergency home visits, chronic care
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52 24 management or treatment of complex wounds [7]. Eventually, the GP decides
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54 25 which tasks are performed by HCAs and how far they perform them
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1 independently. While this approach meets individual eligibility, more
2 standardization may be favourable to identify tasks to be shared in team
3 according to their effect on care quality and efficacy. Furthermore, it could help
4 to reveal potential limitations, as found in nurse-led self-management programs
5 of COPD, which have been associated with higher airway-related mortality
6 [15,24]. A promising approach for a standardized involvement of HCAs certainly
7 lies in chronic disease management programs, which proved to be efficient for
8 heart failure or asthma bronchiale [23,25,26]. New IT-based methods such as
9 web-based telemedical care, which has been shown to prevent hospital
10 admissions and reduce all-cause mortality in heart failure patients, should also
11 be considered [27]. Finally, standardized translational approaches after hospital
12 release are promising to reduce readmission rates [28,29].

13 To our knowledge, this high-volume cross-sectional study is the first study
14 indicating that involvement of highly qualified non-physician health care
15 professionals to primary care has a beneficial effect on the rate of hospital
16 admissions, specialist consultations and overall medication costs.

17 Limitations are given by the study design and the associated risk of confounding
18 factors. Due the nature of claims data, the parameters available for analysis
19 were limited. Consequently, the evaluation of relevant patient-reported
20 outcomes such as e.g. quality of life was not possible in this analysis.
21 Furthermore, the omission of practice details was an important element of the
22 data protection contract for participating practices with the objective not to be
23 identifiable by researchers. Potentially relevant structural factors such as
24 educational level and experience of the staff or structural characteristics of the
25 practices like equipment or procedural factors such as available diagnostics

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1 and treatment options, were not available for this analysis. Consequently,
2 limitations given by the nature of claims data have to be considered. On the
3 other hand, we deliberately chose claims data for this analysis due to the high
4 volume and statistical power necessary to assess the chosen outcomes.
5 Furthermore, in our opinion the available structural factors included in this
6 analysis represent an appropriate and best possible adjustment for the
7 measured outcomes.

8 This high-volume cross-sectional study showed that involving highly qualified
9 non-physician health care professionals in primary care is associated with a
10 reduction in hospital admissions, specialist consultations and overall
11 medication costs. Consequently, this may be a successful strategy not only to
12 alleviate physicians' work load, but to improve quality and efficacy of primary
13 care to meet future health care challenges. Further studies should explore
14 specific tasks to be shared with non-physician workforces and standardization
15 of the professional role.

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2 Wuerttemberg (Germany) for providing pseudonymized data for this analysis.

Contributors

3 Jonas D. Senft: design and methods, writing the article; Regina Poss-Doering:
4 data interpretation, revision of the article; Michel Wensing: data interpretation,
5 revision of the article; Joachim Szecsenyi: design and methods, revision of the
6 article; Gunter Laux: design and methods, statistical analysis, revision of the
7 article. All authors commented on the draft and approved the final version of
8 the manuscript.

Competing interests

9 The authors Jonas D. Senft, Regina Poss-Doering, Michel Wensing, Joachim
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Data sharing statement

16 Data used in this analysis are not in the public domain and use is covered by
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References:

1. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Arch Intern Med.* 2002;162: 2269–2276. doi:10.1001/archinte.162.20.2269
2. Fried TR, Tinetti ME, Iannone L. Primary care clinicians' experiences with treatment decision making for older persons with multiple conditions. *Arch Intern Med.* 2011;171: 75–80. doi:10.1001/archinternmed.2010.318
3. Zolnierok KBH, Dimatteo MR. Physician communication and patient adherence to treatment: a meta-analysis. *Med Care.* 2009;47: 826–834. doi:10.1097/MLR.0b013e31819a5acc
4. Kelley JM, Kraft-Todd G, Schapira L, Kossowsky J, Riess H. The influence of the patient-clinician relationship on healthcare outcomes: a systematic review and meta-analysis of randomized controlled trials. *PLoS ONE.* 2014;9: e94207. doi:10.1371/journal.pone.0094207
5. Ghorob A, Bodenheimer T. Sharing the care to improve access to primary care. *N Engl J Med.* 2012;366: 1955–1957. doi:10.1056/NEJMp1202775
6. Freund T, Peters-Klimm F, Boyd CM, Mahler C, Gensichen J, Erler A, et al. Medical Assistant-Based Care Management for High-Risk Patients in Small Primary Care Practices: A Cluster Randomized Clinical Trial. *Ann Intern Med.* 2016;164: 323–330. doi:10.7326/M14-2403
7. Mergenthal K, Beyer M, Gerlach FM, Guethlin C. Sharing Responsibilities within the General Practice Team - A Cross-Sectional Study of Task Delegation in Germany. *PLoS ONE.* 2016;11: e0157248. doi:10.1371/journal.pone.0157248
8. Freund T, Everett C, Griffiths P, Hudon C, Naccarella L, Laurant M. Skill mix, roles and remuneration in the primary care workforce: who are the healthcare professionals in the primary care teams across the world? *Int J Nurs Stud.* 2015;52: 727–743. doi:10.1016/j.ijnurstu.2014.11.014
9. Donald F, Martin-Misener R, Bryant-Lukosius D, Kilpatrick K, Kaasalainen S, Carter N, et al. The primary healthcare nurse practitioner role in Canada. *Nurs Leadersh (Tor Ont).* 2010;23 Spec No 2010: 88–113.
10. Lukewich J, Edge DS, VanDenKerkhof E, Williamson T, Tranmer J. Association between registered nurse staffing and management outcomes of patients with type 2 diabetes within primary care: a cross-sectional linkage study. *CMAJ Open.* 2016;4: E264-270. doi:10.9778/cmajo.20150113
11. Russell GM, Dahrouge S, Hogg W, Geneau R, Muldoon L, Tuna M. Managing chronic disease in ontario primary care: the impact of

- 1
2
3 1 organizational factors. *Ann Fam Med*. 2009;7: 309–318.
4 2 doi:10.1370/afm.982
5
6 3 12. Halter M, Drennan V, Chattopadhyay K, Carneiro W, Yiallourous J, de
7 4 Lusignan S, et al. The contribution of physician assistants in primary care:
8 5 a systematic review. *BMC Health Serv Res*. 2013;13: 223.
9 6 doi:10.1186/1472-6963-13-223
10
11 7 13. Ruggiero L, Riley BB, Hernandez R, Quinn LT, Gerber BS, Castillo A, et
12 8 al. Medical assistant coaching to support diabetes self-care among low-
13 9 income racial/ethnic minority populations: randomized controlled trial.
14 10 *West J Nurs Res*. 2014;36: 1052–1073. doi:10.1177/0193945914522862
15
16 11 14. Bekelman DB, Plomondon ME, Carey EP, Sullivan MD, Nelson KM,
17 12 Hattler B, et al. Primary Results of the Patient-Centered Disease
18 13 Management (PCDM) for Heart Failure Study: A Randomized Clinical
19 14 Trial. *JAMA Intern Med*. 2015;175: 725–732.
20 15 doi:10.1001/jamainternmed.2015.0315
21
22 16 15. Fan VS, Gaziano JM, Lew R, Bourbeau J, Adams SG, Leatherman S, et
23 17 al. A comprehensive care management program to prevent chronic
24 18 obstructive pulmonary disease hospitalizations: a randomized, controlled
25 19 trial. *Ann Intern Med*. 2012;156: 673–683. doi:10.7326/0003-4819-156-10-
26 20 201205150-00003
27
28 21 16. Connor KI, Cheng EM, Barry F, Siebens HC, Lee ML, Ganz DA, et al.
29 22 Randomized trial of care management to improve Parkinson disease care
30 23 quality. *Neurology*. 2019;92: e1831–e1842.
31 24 doi:10.1212/WNL.0000000000007324
32
33 25 17. Laurant M, van der Biezen M, Wijers N, Watananirun K, Kontopantelis E,
34 26 van Vught AJ. Nurses as substitutes for doctors in primary care. *Cochrane*
35 27 *Database Syst Rev*. 2018;7: CD001271.
36 28 doi:10.1002/14651858.CD001271.pub3
37
38 29 18. Laux G, Kaufmann-Kolle P, Bauer E, Goetz K, Stock C, Szecsenyi J.
39 30 [Evaluation of family doctor centred medical care based on AOK routine
40 31 data in Baden-Württemberg]. *Z Evid Fortbild Qual Gesundheitswes*.
41 32 2013;107: 372–378. doi:10.1016/j.zefq.2013.07.001
42
43 33 19. Fricke U, Hein L, Schwabe U. *Neue Arzneimittel 2016*. In: Schwabe U,
44 34 Paffrath D, Ludwig W-D, Klauber J, editors. *Arzneiverordnungs-Report*
45 35 2017. Berlin, Heidelberg: Springer Berlin Heidelberg; 2017. pp. 55–135.
46 36 doi:10.1007/978-3-662-54630-7_3
47
48 37 20. Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA.
49 38 New ICD-10 version of the Charlson comorbidity index predicted in-
50 39 hospital mortality. *J Clin Epidemiol*. 2004;57: 1288–1294.
51 40 doi:10.1016/j.jclinepi.2004.03.012
52
53
54
55
56
57
58
59
60

- 1
2
3 1 21. Freund T, Mahler C, Erler A, Gensichen J, Ose D, Szecsenyi J, et al.
4 2 Identification of patients likely to benefit from care management programs.
5 3 Am J Manag Care. 2011;17: 345–352.
6
7
8 4 22. Siebenhofer A, Ulrich L-R, Mergenthal K, Berghold A, Pregartner G,
9 5 Kemperdick B, et al. Primary care management for patients receiving
10 6 long-term antithrombotic treatment: A cluster-randomized controlled trial.
11 7 PLoS ONE. 2019;14: e0209366. doi:10.1371/journal.pone.0209366
12
13 8 23. Takeda A, Martin N, Taylor RS, Taylor SJ. Disease management
14 9 interventions for heart failure. Cochrane Database Syst Rev. 2019;1:
15 10 CD002752. doi:10.1002/14651858.CD002752.pub4
16
17
18 11 24. Lenferink A, Brusse-Keizer M, van der Valk PD, Frith PA, Zwerink M,
19 12 Monninkhof EM, et al. Self-management interventions including action
20 13 plans for exacerbations versus usual care in patients with chronic
21 14 obstructive pulmonary disease. Cochrane Database Syst Rev. 2017;8:
22 15 CD011682. doi:10.1002/14651858.CD011682.pub2
23
24
25 16 25. Smith SM, Soubhi H, Fortin M, Hudon C, O'Dowd T. Interventions for
26 17 improving outcomes in patients with multimorbidity in primary care and
27 18 community settings. Cochrane Database Syst Rev. 2012; CD006560.
28 19 doi:10.1002/14651858.CD006560.pub2
29
30
31 20 26. Peytremann-Bridevaux I, Arditi C, Gex G, Bridevaux P-O, Burnand B.
32 21 Chronic disease management programmes for adults with asthma.
33 22 Cochrane Database Syst Rev. 2015; CD007988.
34 23 doi:10.1002/14651858.CD007988.pub2
35
36 24 27. Koehler F, Koehler K, Deckwart O, Prescher S, Wegscheider K, Kirwan
37 25 B-A, et al. Efficacy of telemedical interventional management in patients
38 26 with heart failure (TIM-HF2): a randomised, controlled, parallel-group,
39 27 unmasked trial. Lancet. 2018;392: 1047–1057. doi:10.1016/S0140-
40 28 6736(18)31880-4
41
42
43 29 28. Hesselink G, Schoonhoven L, Barach P, Spijker A, Gademan P, Kalkman
44 30 C, et al. Improving patient handovers from hospital to primary care: a
45 31 systematic review. Ann Intern Med. 2012;157: 417–428.
46 32 doi:10.7326/0003-4819-157-6-201209180-00006
47
48 33 29. Braet A, Weltens C, Sermeus W. Effectiveness of discharge interventions
49 34 from hospital to home on hospital readmissions: a systematic review. JBI
50 35 Database System Rev Implement Rep. 2016;14: 106–173.
51 36 doi:10.11124/jbisrir-2016-2381
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
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	9
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	n/a
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(e) Describe any sensitivity analyses	10
Results			

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	11
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	12
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	12
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
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	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	17

*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.

BMJ Open

Effect of involving certified health care assistants in primary care in Germany: A cross-sectional study

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Manuscripts

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3 **1 Effect of involving certified health care assistants in primary**
4 **2 care in Germany: A cross-sectional study**

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8 3 Short title: Effect of involving certified health care assistants in primary care in
9
10 4 Germany

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13 5 Jonas D. Senft¹, Michel Wensing¹, Regina Poss-Doering¹, Joachim Szecsenyi¹,
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3 **1 Abstract**
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5 **2 Objectives:** Growing prevalence of chronic diseases and limited resources are
6
7 key challenges for future health care. As a promising approach to maintain high-
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9 quality primary care, non-physician health care professionals have been trained
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11 to broaden qualifications and responsibilities. This study aimed to assess the
12
13 influence of involving certified health care assistants (HCAs, German: VERAH)
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17 on quality and efficacy of primary care in Germany.

18
19 **8 Design:** Cross-sectional study
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21 **9 Setting:** Primary care
22

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24 **10 Participants:** Patients insured by the AOK statutory health insurer (Allgemeine
25
26 Ortskrankenkasse, Baden-Wuerttemberg, Germany).
27

28 **12 Interventions:** Since 2008 practice assistants in Germany can enhance their
29
30 professional education to become certified HCAs.
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33 **14 Primary and secondary outcome measures:** Claims data related to patients
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35 treated in practices employing at least one HCA were compared to data from
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37 practices not employing HCAs to determine frequency of consultations, hospital
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39 admissions and readmissions. Economic analysis comprised hospitalization
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41 costs, prescriptions of follow-on drugs and outpatient medication costs.
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44 **19 Results:** A total of 397,493 patients were treated in HCA practices, 463,730
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46 patients attended to non-HCA practices. Patients in HCA practices had an 8.2%
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48 lower rate of specialist consultations ($p<0.0001$), a 4.0% lower rate of
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50 hospitalizations ($p<0.0001$), a 3.5% lower rate of readmissions ($p=0.0463$), a
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52 14.2% lower rate of follow-on drug prescriptions ($p<0.0001$) and 4.7% lower
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54 costs of total medication ($p<0.0001$). No difference was found regarding the
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56 consultation rate of general practitioners and hospital costs.
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3 1 **Conclusions:** For the first time this high-volume claims data analysis showed
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5 2 that involving HCAs in primary care in Germany is associated with a reduction
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7 3 in hospital admissions, specialist consultations and medication costs.
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10 4 Consequently, broadening qualifications may be a successful strategy not only
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12 5 to share physicians' work load but to improve quality and efficacy in primary
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14 6 care to meet future challenges. Future studies may explore specific tasks to be
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16 7 shared with non-physician workforces and standardization of the professional
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1 **Strengths and limitations of this study**

- 2 • This is the first high-volume claims data analysis assessing the effect of
3 involving higher qualified practice assistants on quality and efficacy health
4 care indicators in Germany.
- 5 • The analysis is performed on a comprehensive sample of data of one year
6 covering 861,223 patients.
- 7 • Statistical adjustment was possible for relevant patient-sided factors like
8 patients' age and morbidity, nursing care level and structural factors like
9 practice size, urbanization and type (single or group practice).
- 10 • Due to the limitations given by the nature of claims data, further potentially
11 relevant factors like educational level and experience of the staff were not
12 available for this analysis.
- 13 • The professional role of HCAs in Germany is not standardized, thus
14 limitations are given to the transferability of the intervention.

1
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3 **1 Abbreviations:**
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- 5 2 AOK statutory health insurance provider (German: Allgemeine
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7 Ortskrankenkasse)
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10 4 GP general practitioner
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12 5 HCA health care assistant
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14 6 HZV GP-centered care (German: Hausarztzentrierte Versorgung)
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16 7 PZN central pharmaceutical number (Pharmazentralnummer)
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For peer review only

1 Introduction

2 All over the globe, providing access to high-quality primary care is a challenge
3 for health care systems. In the view of growing prevalence of chronic diseases
4 and limited health care resources, physicians are confronted with increasing
5 numbers of consultations while time is very limited [1,2].

6 Particularly in times of evidence-based practice and growing use of treatment
7 algorithms, time is needed to meet patient's individual preferences or
8 circumstances, which are deciding factors for treatment success [3,4].

9 Consequently, strategies are needed to maintain access to high-quality general
10 practice. As a promising worldwide approach, highly qualified non-physician
11 health care professionals such as practice nurses in the U.S. or in Australia are
12 trained to take a more active role in primary care, particularly in treatment of
13 patients with chronic diseases [5–8]. For primary healthcare registered nurses
14 and nurse practitioners in Canada, there is growing evidence that their
15 involvement in practices is associated with health promotion, particularly in the
16 management of chronic diseases [9–11].

17 While qualified nurses are well integrated in primary care in other countries, in
18 Germany so far there is no professional role for nurses in general medicine. On
19 the other hand, non-academic workforces like practice or medical assistants
20 have become increasingly involved into active patient care as they have been
21 integrated into treatment monitoring or patient coaching for chronic diseases
22 like diabetes e.g. in the United States [8,12,13]. In Germany, general
23 practitioners (GP) usually employ certified practice assistants, who absolved
24 professional training for three years and traditionally performed clerical duties
25 like reception and routine tasks, such as blood sampling or electrocardiogram

1 recording. Since 2008 practical assistants may undergo an additional training
2 program of 200 hours to become certified as a so-called health care assistant
3 (German: "Versorgungsassistent/in in der Hausarztpraxis", VERAH). Health
4 care assistants (HCAs) are qualified to be closer involved in primary care
5 delivery performing tasks such as team-based case management and
6 monitoring of chronically-ill patients, routine home visits, and wound care [7].
7 However, to date there is only limited knowledge about the effect of broadening
8 skills and responsibilities of non-physician workforces on quality and efficacy of
9 primary care. Recent RCTs did not find a beneficial effect of disease
10 management programs led by non-physician work forces on care indicators like
11 hospitalization rate or health care costs [14–16]. A recent meta-analysis of 18
12 RCTs assessing the influence of nurses working as a substitute for physicians
13 showed that nurse-led care may be equal in terms of health outcomes like
14 control of diabetes and blood pressure and patient satisfaction [17].
15 However, no evidence-based conclusion can be drawn currently with regard to
16 the influence of involving higher qualified non-physician workforce on health
17 care efficacy indicators like hospitalization rate, specialist consultations and
18 costs. Furthermore, common sample sizes of available RCTs may be
19 underpowered to capture effects in this regard. The aim of this study was to
20 assess the influence of involving certified health care assistants on quality and
21 efficacy of primary care in Germany. For this purpose, for the first time a high-
22 volume claims data cross-sectional study was performed.

1 **Methods**

2 Study Design

3 A cross-sectional study was conducted. Claims data related to patients treated
4 in general practices between January 1 and December 31, 2014 were supplied
5 by the AOK statutory health insurance company (German: "Allgemeine
6 Ortskrankenkasse", Baden-Wuerttemberg, Germany). Data of patients treated
7 in practices employing at least one certified HCA were compared to data from
8 practices not employing HCAs (non-HCA) to assess the influence of involving
9 HCAs in primary care delivery. Ethical approval for this study was given by the
10 local institutional Ethics Committee of the University Hospital Heidelberg (No.
11 S-359/2013).

12 Study population

13 Secondary data related to patients insured by the AOK statutory health
14 insurance company of Baden-Wuerttemberg, Germany, and participating in a
15 specific primary care program in Germany (GP-centred care; German:
16 "Hausarztzentrierte Versorgung" (HZV)) were eligible for data analysis. The
17 federal state of Baden-Wuerttemberg has a population of about 10.7 million and
18 AOK is the largest statutory health insurer with about 4 million insured persons.
19 The HZV program is a large-scale, legally stipulated care concept encouraging
20 patients to enroll with a general practitioner (GP), aiming to strengthen primary
21 care and to enhance health care for patients with chronic diseases and complex
22 health care needs [18]. Secondary patient data were included in the analysis, if
23 patients met the following criteria: aged 18 years or older, living in Baden-
24 Wuerttemberg, at least one visit to the primary care physician in the relevant

1
2
3 1 year, no registration with other primary care contracts (e.g., integrated care
4
5 2 contracts), no interruptions of registration to HZV program in the relevant year.

6 7 8 3 Intervention

9
10 4 Since 2008, practice assistants working in practices participating in the HZV
11
12 5 program in Germany, can enhance their professional education by attending a
13
14 6 standardized curriculum of 200 teaching units of theoretical and practical
15
16 7 lessons. Upon mandatory examination, these practice assistants become state-
17
18 8 certified as HCA (German: VERAH) [7]. Besides routine tasks like blood
19
20 9 sampling, electrocardiogram recording or spirometry, HCAs are thought to
21
22 10 perform monitoring of chronically-ill patients, prevention measures, routine
23
24 11 home visits and wound care management.

25 26 27 28 12 Data acquisition and outcome parameters

29
30 13 Secondary patient data were recorded by the AOK state health insurance
31
32 14 company for reimbursement purposes and continuous evaluation of the HZV
33
34 15 program. For the analysis, data were supplied by the AOK to the Department
35
36 16 of General Practice and Health Services Research, University Hospital
37
38 17 Heidelberg. Practices employing certified HCAs could be unambiguously
39
40 18 identified since employment of HCAs is obligatorily reimbursed by state health
41
42 19 insurance in the HZV program. The claims data consisted of several data sets,
43
44 20 containing particular information on patient care (e. g. GP consultations,
45
46 21 prescriptions and hospitalizations). These data could be linked on the basis of
47
48 22 a unique patient identifier. Data linkage was performed by our research team
49
50 23 using a relational database. Subjects cannot be identified, directly or through
51
52 24 identifiers linked to the subjects. Data storage and extraction were performed
53
54 25 with MySQL Community Server x64 (Oracle Corporation, Redwood Shores,
55
56
57
58
59
60

1 CA, USA). All national and institutional guidelines concerning data acquisition
2 for retrospective analyses were followed at all times.

3 The obtained data set comprised age, gender, diagnoses according to ICD-10
4 coding as well as accounting data on consultations, prescribed medication and
5 hospital stays.

6 To assess the effect of involving HCAs on quality and efficacy of primary care,
7 the following outcome parameters were analyzed: GP consultations, specialist
8 consultations, hospital admissions, hospital readmissions within 4 weeks,
9 hospitalization costs, prescription of follow-on drugs and outpatient medication
10 costs. The number of GP and specialist consultations per patient could be
11 determined by the codes according to the EBM system (“Einheitlicher
12 Bewertungsmaßstab”) used for accounting of outpatient medical services in
13 Germany. Number of hospital admissions and readmissions per patient as well
14 as per-patient costs for hospitalization in € was determined by the recorded
15 Diagnosis Related Groups (DRG) codes used for reimbursement of inpatient
16 medical services in Germany. The per-patient number of prescriptions of so-
17 called follow-on drugs, patent-secured marginally altered pharmaceuticals with
18 no benefit compared to the prototype drug according to evidence-based criteria
19 [19], was determined by records of the central pharmaceutical numbers of
20 prescribed medications (“Pharmazentralnummer”, PZN). Outpatient medication
21 costs per patient in € could be determined by accounting data for prescriptions
22 reimbursed by the AOK state health insurance.

23 Statistical analysis

24 The full sample of available claims data was used for the analysis. In order to
25 calculate frequencies, rates and percentages, we used SAS PROC SQL. In

1
2
3 1 order to assess the adjusted outcomes of interest, we used SAS PROC
4
5 2 GENMOD (SAS V.9.4×64, SAS Institute). There was no missing data within the
6
7 3 underlying data set. If there was no utilization for a particular patient, e.g. no
8
9 4 hospitalization, this was denoted as “0”. The following factors were selected ex
10
11 5 ante for the adjustment of the comparison between groups: patient age, sex,
12
13 6 morbidity according to Charlson Index [20], nursing home as residence, nursing
14
15 7 care level (legally defined 4-point scale to assess need for nursing support),
16
17 8 urbanization (rural, urban), practice size (number of contacts in relevant
18
19 9 period), type of practice (single, group). Comparison between groups was done
20
21 10 by multivariable regression analysis, which the three-level clustering of
22
23 11 patients, GPs and practices into account. Depending on the distribution of each
24
25 12 outcome, linear regression, negative-binomial regression or Poisson
26
27 13 regression models (for count data) were used. Since multiple hypotheses were
28
29 14 tested in this analysis, the Bonferroni correction was used to compensate for
30
31 15 multiple comparisons. For all analyses, results were considered statistically
32
33 16 significant, if the p value was 0.05 or less.

34 17 Patient and public involvement

35 18 Exploring strategies to provide and maintain access to high-quality primary care
36
37 19 is of public interest, particularly in the view of growing prevalence of chronic
38
39 20 diseases and limited health care resources. Due to the retrospective study
40
41 21 design based on an analysis of pseudonymized data, patients could not be
42
43 22 identified, nor be informed or involved into this study. The public dissemination
44
45 23 of the results is intended to be achieved by scientific publication.

1 Results

2 861,223 patients were evaluated in the observation period from January 1 to
3 December 31, 2014. 397.493 patients were treated in practices involving at
4 least one HCA to primary care (HCA group), 463.730 patients were seen in
5 practices, which did not employ HCAs (non-HCA group). Patients
6 characteristics are shown in Table 1.

Table 1: Patient characteristics: Data of patients treated in practices employing
at least one HCA compared to practices not employing HCAs (non-HCA)

	HCA	Non-HCA	p
Number of patients	397493	463730	
Male (N, %)	174415 (43.9%)	200775 (43.2%)	<0.0001
Age	56.9 ± 18.5	58.4 ± 18.1	<0.0001
Charlson Index	1.37 ± 2.0	1.38 ± 1.98	<0.0001
Care level [N]			<0.0001
No care:	378919	442024	
I:	11186	13165	
II:	5771	6765	
III:	1593	1751	
IV:	24	25	

Continuous values are presented as mean ± standard deviation; HCA: health care assistant;

7 According to the adjusted analysis, patients in the HCA-group had an 8.2%
8 lower rate of specialist consultations ($p < 0.0001$). Per-patient number of hospital
9 admissions was 4.0% lower ($p < 0.0001$) and number of hospital readmissions
10 was 3.5% lower in the HCA group ($p = 0.0463$). Prescriptions of follow-on drugs
11 were 14.2% lower and total outpatient medication costs were 4.69% lower in
12 the HCA-group respectively ($p < 0.0001$). No difference was found regarding the
13 number of GP consultations and hospitalization costs (Table 2).

Table 2: Outcomes: Outcome parameters for patients treated in practices employing at least one HCA compared to practices not employing HCAs (non-HCA)

Per-patient outcome	Unadjusted Outcome		Adjusted Difference (AD) HCA vs. non-HCA		
	HCA	Non-HCA	AD [95%CI]	AD in %	p
GP consultations	13.46 ± 11.42	13.72 ± 11.81	-0.063 ± 0.021 [-0.105, -0.022]	-0.21%	0.0028
Specialist consultations	4.59 ± 8.23	4.89 ± 8.38	-0.209 ± 0.018 [-0.245, 0.173]	-8.21%	<0.0001
Hospital admissions	0.272 ± 0.762	0.286 ± 0.790	-0.013 ± 0.008 [-0.057, -0.025]	-4.00%	<0.0001
Hospital readmissions	0.210 ± 0.682	0.216 ± 0.721	-0.036 ± 0.018 [-0.071, -0.006]	-3.53%	0.0463
Hospitalization costs [€]	6,239 ± 9,388	6319 ± 9278	-40.42 ± 0.005 [-0.018, 0.003]	0.73%	0.1711
Prescription of follow-on drugs	3.12 ± 10.15	3.57 ± 10.89	-0.388 ± 0.026 [-0.437, -0.334]	-14.2%	<0.0001
Outpatient medication costs [€]	1,333 ± 59,877	1376 ± 51567	-71.01 ± 0.011 [-0.070, -0.026]	4.69%	<0.0001

Values are presented as mean ± standard deviation; AD: adjusted difference; GP: general practitioner;

HCA: health care assistant; CI: confidence interval

1 Discussion

2 For the first time, this cross-sectional study assessed high-volume claims data
3 to evaluate the influence of involving HCAs on quality and efficacy of primary
4 care in Germany. The analysis of care-related data of 861,223 patients showed
5 a lower rate of hospital admissions, specialist consultations as well as lower
6 outpatient medication costs when HCAs were part of the practice staff.
7 Although the measured effect is low-scaled, it is of high relevance for the
8 development of future primary care concepts. From a patient-centered view,
9 avoiding hospitalization or unnecessary medication may help to reduce
10 patients' burden and morbidity due to hospital stay or pharmacological side-
11 effects. On the other hand, avoidable treatment will be not only a central
12 determinant of quality, but a key cost factor for health care systems, which will
13 be challenged by the rising prevalence of chronic diseases in the future.

14 The measured effect may be hypothesized to be due to an improved patient
15 access to primary care. Either directly by being attended to by an HCA, or
16 indirectly by improvement of workflow, patients may benefit from a higher
17 quality and efficacy of care. Hospitalizations and specialist consultations may
18 be avoided by a more intensive outpatient care facilitated by HCA involvement.
19 Particularly, patients with chronic diseases may benefit from extended services
20 like intense monitoring, education and reminders [21]. And eventually, costs for
21 prescriptions may be reduced by efficient management of medication regimen.

22 To date, knowledge about potential effects of involving higher qualified non-
23 physician healthcare professionals in primary care is low. Several RCTs
24 evaluating disease management programs for chronic conditions like chronic
25 pulmonary disease or heart failure involved practice assistants with enhanced

1 educational training and responsibilities, however, did not prove an effect of
2 these programs on relevant care indicators [6,15,22]. A potential reason for
3 this contrast to our findings may be an underpowered sample-size postulating
4 a reduction of avoidable hospitalizations up to 20%. The results of our study
5 show a much smaller effect with a reduction of 4% hospitalizations when HCAs
6 were involved, which in our opinion is closer to reality in primary care. As a
7 comparison, even in settings of complex disease management programs for
8 heart failure patients, low rates of reduction in all-cause hospitalization are
9 common when involving academically educated non-physician work forces and
10 specialist physicians, with a range of up to 8% as a recent meta-analysis of 12
11 RCTs showed [23].

12 Another relevant finding of this study is that the rate of GP consultations was
13 only slightly reduced by 0.21% when HCAs were involved. This is noteworthy,
14 since a distinct reduction of GP consultations might have been expected
15 assuming that HCAs perform chosen routine tasks independently. On the
16 other hand, this result may reflect that involvement of HCAs is not implemented
17 as a one-way delegation or as a substitution for physician care as has been
18 proposed for nurse-led care concepts [17], but more as a team interaction.
19 However, no conclusion can be drawn by this study with regard to the specific
20 role of HCAs within the practice staff. As a recent survey showed, in Germany
21 there is no firmly standardized professional role for HCAs. Performed tasks
22 differ widely from simple patient assessment or basic wound care to tasks with
23 substantial responsibility like emergency home visits, chronic care
24 management or treatment of complex wounds [7]. Eventually, the GP decides
25 which tasks are performed by HCAs and to what extent they perform them

1 independently. While this approach meets individual eligibility, more
2 standardization may be favourable to identify tasks to be shared in teams
3 according to their effect on care quality and efficacy. Furthermore, it could help
4 to reveal potential limitations, as found in nurse-led self-management programs
5 of COPD, which have been associated with higher airway-related mortality
6 [15,24]. A promising approach for a standardized involvement of HCAs certainly
7 lies in chronic disease management programs, which proved to be efficient for
8 heart failure or asthma bronchiale [23,25,26]. Furthermore, patient monitoring
9 by HCAs could be supported using new IT-based methods such as web-based
10 telemedical care, which has been shown to prevent hospital admissions and
11 reduce all-cause mortality in heart failure patients [27]. Finally, involving HCAs
12 in standardized translational approaches after hospital release may be
13 promising to reduce readmission rates [28,29].

14 Limitations are given by the study design and the associated risk of confounding
15 factors. Due to the nature of claims data, the parameters available for analysis
16 were limited. The omission of practice details was an important element of the
17 data protection contract for participating practices with the objective not to be
18 identifiable by researchers. Thus, further potentially relevant factors such as
19 educational level and experience of the staff or structural characteristics of the
20 practices like equipment or procedural factors such as available diagnostics
21 and treatment options, were not available for this analysis. Furthermore, the
22 evaluation of relevant patient-reported outcomes such as quality of life was not
23 possible in this analysis. Consequently, in our opinion a structure-process-
24 outcome model was not feasible to be applied in this study. On the other hand,
25 we deliberately chose claims data for this analysis due to the high volume and

1 statistical power necessary to assess the chosen outcomes. Furthermore, in
2 our opinion the available structural factors included in this analysis represent
3 an appropriate and best possible adjustment for the measured outcomes.
4 This high-volume cross-sectional study showed that involving HCAs in primary
5 care in Germany is associated with a reduction in hospital admissions,
6 specialist consultations and overall medication costs. Consequently,
7 broadening qualifications and responsibilities of non-physician work forces may
8 be a successful strategy not only to alleviate physicians' workload, but to
9 improve quality and efficacy of primary care to meet future health care
10 challenges. Further studies should explore specific tasks to be shared with non-
11 physician workforces and standardization of the professional role.

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2 Wuerttemberg (Germany) for providing pseudonymized data for this analysis.

Contributors

3 Jonas D. Senft: design and methods, writing the article; Regina Poss-Doering:
4 data interpretation, revision of the article; Michel Wensing: data interpretation,
5 revision of the article; Joachim Szecsenyi: design and methods, revision of the
6 article; Gunter Laux: design and methods, statistical analysis, revision of the
7 article. All authors commented on the draft and approved the final version of
8 the manuscript.

Competing interests

9 The authors Jonas D. Senft, Regina Poss-Doering, Michel Wensing, Joachim
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Data sharing statement

16 Data used in this analysis are not in the public domain and use is covered by
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References:

1. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Arch Intern Med.* 2002;162: 2269–2276. doi:10.1001/archinte.162.20.2269
2. Fried TR, Tinetti ME, Iannone L. Primary care clinicians' experiences with treatment decision making for older persons with multiple conditions. *Arch Intern Med.* 2011;171: 75–80. doi:10.1001/archinternmed.2010.318
3. Zolnierok KBH, Dimatteo MR. Physician communication and patient adherence to treatment: a meta-analysis. *Med Care.* 2009;47: 826–834. doi:10.1097/MLR.0b013e31819a5acc
4. Kelley JM, Kraft-Todd G, Schapira L, Kossowsky J, Riess H. The influence of the patient-clinician relationship on healthcare outcomes: a systematic review and meta-analysis of randomized controlled trials. *PLoS ONE.* 2014;9: e94207. doi:10.1371/journal.pone.0094207
5. Ghorob A, Bodenheimer T. Sharing the care to improve access to primary care. *N Engl J Med.* 2012;366: 1955–1957. doi:10.1056/NEJMp1202775
6. Freund T, Peters-Klimm F, Boyd CM, Mahler C, Gensichen J, Erler A, et al. Medical Assistant-Based Care Management for High-Risk Patients in Small Primary Care Practices: A Cluster Randomized Clinical Trial. *Ann Intern Med.* 2016;164: 323–330. doi:10.7326/M14-2403
7. Mergenthal K, Beyer M, Gerlach FM, Guethlin C. Sharing Responsibilities within the General Practice Team - A Cross-Sectional Study of Task Delegation in Germany. *PLoS ONE.* 2016;11: e0157248. doi:10.1371/journal.pone.0157248
8. Freund T, Everett C, Griffiths P, Hudon C, Naccarella L, Laurant M. Skill mix, roles and remuneration in the primary care workforce: who are the healthcare professionals in the primary care teams across the world? *Int J Nurs Stud.* 2015;52: 727–743. doi:10.1016/j.ijnurstu.2014.11.014
9. Donald F, Martin-Misener R, Bryant-Lukosius D, Kilpatrick K, Kaasalainen S, Carter N, et al. The primary healthcare nurse practitioner role in Canada. *Nurs Leadersh (Tor Ont).* 2010;23 Spec No 2010: 88–113.
10. Lukewich J, Edge DS, VanDenKerkhof E, Williamson T, Tranmer J. Association between registered nurse staffing and management outcomes of patients with type 2 diabetes within primary care: a cross-sectional linkage study. *CMAJ Open.* 2016;4: E264-270. doi:10.9778/cmajo.20150113
11. Russell GM, Dahrouge S, Hogg W, Geneau R, Muldoon L, Tuna M. Managing chronic disease in ontario primary care: the impact of

- 1
2
3 1 organizational factors. *Ann Fam Med*. 2009;7: 309–318.
4 2 doi:10.1370/afm.982
5
6 3 12. Halter M, Drennan V, Chattopadhyay K, Carneiro W, Yiallourous J, de
7 4 Lusignan S, et al. The contribution of physician assistants in primary care:
8 5 a systematic review. *BMC Health Serv Res*. 2013;13: 223.
9 6 doi:10.1186/1472-6963-13-223
10
11 7 13. Ruggiero L, Riley BB, Hernandez R, Quinn LT, Gerber BS, Castillo A, et
12 8 al. Medical assistant coaching to support diabetes self-care among low-
13 9 income racial/ethnic minority populations: randomized controlled trial.
14 10 *West J Nurs Res*. 2014;36: 1052–1073. doi:10.1177/0193945914522862
15
16 11 14. Bekelman DB, Plomondon ME, Carey EP, Sullivan MD, Nelson KM,
17 12 Hattler B, et al. Primary Results of the Patient-Centered Disease
18 13 Management (PCDM) for Heart Failure Study: A Randomized Clinical
19 14 Trial. *JAMA Intern Med*. 2015;175: 725–732.
20 15 doi:10.1001/jamainternmed.2015.0315
21
22 16 15. Fan VS, Gaziano JM, Lew R, Bourbeau J, Adams SG, Leatherman S, et
23 17 al. A comprehensive care management program to prevent chronic
24 18 obstructive pulmonary disease hospitalizations: a randomized, controlled
25 19 trial. *Ann Intern Med*. 2012;156: 673–683. doi:10.7326/0003-4819-156-10-
26 20 201205150-00003
27
28 21 16. Connor KI, Cheng EM, Barry F, Siebens HC, Lee ML, Ganz DA, et al.
29 22 Randomized trial of care management to improve Parkinson disease care
30 23 quality. *Neurology*. 2019;92: e1831–e1842.
31 24 doi:10.1212/WNL.0000000000007324
32
33 25 17. Laurant M, van der Biezen M, Wijers N, Watananirun K, Kontopantelis E,
34 26 van Vught AJ. Nurses as substitutes for doctors in primary care. *Cochrane*
35 27 *Database Syst Rev*. 2018;7: CD001271.
36 28 doi:10.1002/14651858.CD001271.pub3
37
38 29 18. Laux G, Kaufmann-Kolle P, Bauer E, Goetz K, Stock C, Szecsenyi J.
39 30 [Evaluation of family doctor centred medical care based on AOK routine
40 31 data in Baden-Württemberg]. *Z Evid Fortbild Qual Gesundheitsw*.
41 32 2013;107: 372–378. doi:10.1016/j.zefq.2013.07.001
42
43 33 19. Fricke U, Hein L, Schwabe U. *Neue Arzneimittel 2016*. In: Schwabe U,
44 34 Paffrath D, Ludwig W-D, Klauber J, editors. *Arzneiverordnungs-Report*
45 35 2017. Berlin, Heidelberg: Springer Berlin Heidelberg; 2017. pp. 55–135.
46 36 doi:10.1007/978-3-662-54630-7_3
47
48 37 20. Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA.
49 38 New ICD-10 version of the Charlson comorbidity index predicted in-
50 39 hospital mortality. *J Clin Epidemiol*. 2004;57: 1288–1294.
51 40 doi:10.1016/j.jclinepi.2004.03.012
52
53
54
55
56
57
58
59
60

- 1
2
3 1 21. Freund T, Mahler C, Erler A, Gensichen J, Ose D, Szecsenyi J, et al.
4 2 Identification of patients likely to benefit from care management programs.
5 3 Am J Manag Care. 2011;17: 345–352.
6
7
8 4 22. Siebenhofer A, Ulrich L-R, Mergenthal K, Berghold A, Pregartner G,
9 5 Kemperdick B, et al. Primary care management for patients receiving
10 6 long-term antithrombotic treatment: A cluster-randomized controlled trial.
11 7 PLoS ONE. 2019;14: e0209366. doi:10.1371/journal.pone.0209366
12
13 8 23. Takeda A, Martin N, Taylor RS, Taylor SJ. Disease management
14 9 interventions for heart failure. Cochrane Database Syst Rev. 2019;1:
15 10 CD002752. doi:10.1002/14651858.CD002752.pub4
16
17
18 11 24. Lenferink A, Brusse-Keizer M, van der Valk PD, Frith PA, Zwerink M,
19 12 Monninkhof EM, et al. Self-management interventions including action
20 13 plans for exacerbations versus usual care in patients with chronic
21 14 obstructive pulmonary disease. Cochrane Database Syst Rev. 2017;8:
22 15 CD011682. doi:10.1002/14651858.CD011682.pub2
23
24
25 16 25. Smith SM, Soubhi H, Fortin M, Hudon C, O'Dowd T. Interventions for
26 17 improving outcomes in patients with multimorbidity in primary care and
27 18 community settings. Cochrane Database Syst Rev. 2012; CD006560.
28 19 doi:10.1002/14651858.CD006560.pub2
29
30
31 20 26. Peytremann-Bridevaux I, Arditi C, Gex G, Bridevaux P-O, Burnand B.
32 21 Chronic disease management programmes for adults with asthma.
33 22 Cochrane Database Syst Rev. 2015; CD007988.
34 23 doi:10.1002/14651858.CD007988.pub2
35
36 24 27. Koehler F, Koehler K, Deckwart O, Prescher S, Wegscheider K, Kirwan
37 25 B-A, et al. Efficacy of telemedical interventional management in patients
38 26 with heart failure (TIM-HF2): a randomised, controlled, parallel-group,
39 27 unmasked trial. Lancet. 2018;392: 1047–1057. doi:10.1016/S0140-
40 28 6736(18)31880-4
41
42
43 29 28. Hesselink G, Schoonhoven L, Barach P, Spijker A, Gademan P, Kalkman
44 30 C, et al. Improving patient handovers from hospital to primary care: a
45 31 systematic review. Ann Intern Med. 2012;157: 417–428.
46 32 doi:10.7326/0003-4819-157-6-201209180-00006
47
48 33 29. Braet A, Weltens C, Sermeus W. Effectiveness of discharge interventions
49 34 from hospital to home on hospital readmissions: a systematic review. JBI
50 35 Database System Rev Implement Rep. 2016;14: 106–173.
51 36 doi:10.11124/jbisrir-2016-2381
52
53
54 37
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
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	9
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	n/a
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(e) Describe any sensitivity analyses	10
Results			

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	11
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	12
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	12
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
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	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	17

*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.

BMJ Open

Effect of involving certified health care assistants in primary care in Germany: A cross-sectional study

Journal:	<i>BMJ Open</i>
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Manuscripts

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3 **1 Effect of involving certified health care assistants in primary**
4 **2 care in Germany: A cross-sectional study**

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8 3 Short title: Effect of involving certified health care assistants in primary care in
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10 4 Germany

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3 **1 Abstract**
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5 **2 Objectives:** Growing prevalence of chronic diseases and limited resources are
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7 key challenges for future health care. As a promising approach to maintain high-
8
9 quality primary care, non-physician health care professionals have been trained
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11 to broaden qualifications and responsibilities. This study aimed to assess the
12
13 influence of involving certified health care assistants (HCAs, German: VERAH)
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17 on quality and efficacy of primary care in Germany.
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19 **8 Design:** Cross-sectional study
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21 **9 Setting:** Primary care
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23
24 **10 Participants:** Patients insured by the AOK statutory health insurer (Allgemeine
25
26 Ortskrankenkasse, Baden-Wuerttemberg, Germany).
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28 **12 Interventions:** Since 2008 practice assistants in Germany can enhance their
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30 professional education to become certified HCAs.
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32
33 **14 Primary and secondary outcome measures:** Claims data related to patients
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35 treated in practices employing at least one HCA were compared to data from
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37 practices not employing HCAs to determine frequency of consultations, hospital
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39 admissions and readmissions. Economic analysis comprised hospitalization
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41 costs, prescriptions of follow-on drugs and outpatient medication costs.
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44 **19 Results:** A total of 397,493 patients were treated in HCA practices, 463,730
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46 patients attended to non-HCA practices. Patients in HCA practices had an 8.2%
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48 lower rate of specialist consultations ($p < 0.0001$), a 4.0% lower rate of
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50 hospitalizations ($p < 0.0001$), a 3.5% lower rate of readmissions ($p = 0.0463$), a
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52 14.2% lower rate of follow-on drug prescriptions ($p < 0.0001$) and 4.7% lower
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54 costs of total medication ($p < 0.0001$). No difference was found regarding the
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56 consultation rate of general practitioners and hospital costs.
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3 1 **Conclusions:** For the first time this high-volume claims data analysis showed
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5 2 that involving HCAs in primary care in Germany is associated with a reduction
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7 3 in hospital admissions, specialist consultations and medication costs.
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10 4 Consequently, broadening qualifications may be a successful strategy not only
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12 5 to share physicians' work load but to improve quality and efficacy in primary
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14 6 care to meet future challenges. Future studies may explore specific tasks to be
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16 7 shared with non-physician workforces and standardization of the professional
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18 8 role.
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1 **Strengths and limitations of this study**

- 2 • This is the first high-volume claims data analysis assessing the effect of
3 involving higher qualified practice assistants on quality and efficacy health
4 care indicators in Germany.
- 5 • The analysis is performed on a comprehensive sample of data of one year
6 covering 861,223 patients.
- 7 • Statistical adjustment was possible for relevant patient-sided factors like
8 patients' age and morbidity, nursing care level and structural factors like
9 practice size, urbanization and type (single or group practice).
- 10 • Due to the limitations given by the nature of claims data, further potentially
11 relevant factors like educational level and experience of the staff were not
12 available for this analysis.
- 13 • The professional role of HCAs in Germany is not standardized, thus
14 limitations are given to the transferability of the intervention.

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3 **1 Abbreviations:**
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- 5 2 AOK statutory health insurance provider (German: Allgemeine
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7 Ortskrankenkasse)
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10 4 GP general practitioner
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12 5 HCA health care assistant
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14 6 HZV GP-centered care (German: Hausarztzentrierte Versorgung)
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16 7 PZN central pharmaceutical number (Pharmazentralnummer)
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For peer review only

1 Introduction

2 All over the globe, providing access to high-quality primary care is a challenge
3 for health care systems. In the view of growing prevalence of chronic diseases
4 and limited health care resources, physicians are confronted with increasing
5 numbers of consultations while time is very limited [1,2].

6 Particularly in times of evidence-based practice and growing use of treatment
7 algorithms, time is needed to meet patient's individual preferences or
8 circumstances, which are deciding factors for treatment success [3,4].

9 Consequently, strategies are needed to maintain access to high-quality general
10 practice. As a promising worldwide approach, highly qualified non-physician
11 health care professionals such as practice nurses in the U.S. or in Australia are
12 trained to take a more active role in primary care, particularly in treatment of
13 patients with chronic diseases [5–8]. For primary healthcare registered nurses
14 and nurse practitioners in Canada, there is growing evidence that their
15 involvement in practices is associated with health promotion, particularly in the
16 management of chronic diseases [9–11].

17 While qualified nurses are well integrated in primary care in other countries, in
18 Germany so far there is no professional role for nurses in general medicine. On
19 the other hand, non-academic workforces like practice or medical assistants
20 have become increasingly involved into active patient care as they have been
21 integrated into treatment monitoring or patient coaching for chronic diseases
22 like diabetes e.g. in the United States [8,12,13]. In Germany, general
23 practitioners (GP) usually employ certified practice assistants, who absolved
24 professional training for three years and traditionally performed clerical duties
25 like reception and routine tasks, such as blood sampling or electrocardiogram

1 recording. Since 2008 practical assistants may undergo an additional training
2 program of 200 hours to become certified as a so-called health care assistant
3 (German: "Versorgungsassistent/in in der Hausarztpraxis", VERAH). Health
4 care assistants (HCAs) are qualified to be closer involved in primary care
5 delivery performing tasks such as team-based case management and
6 monitoring of chronically-ill patients, routine home visits, and wound care [7].
7 However, to date there is only limited knowledge about the effect of broadening
8 skills and responsibilities of non-physician workforces on quality and efficacy of
9 primary care. Recent RCTs did not find a beneficial effect of disease
10 management programs led by non-physician work forces on care indicators like
11 hospitalization rate or health care costs [14–16]. A recent meta-analysis of 18
12 RCTs assessing the influence of nurses working as a substitute for physicians
13 showed that nurse-led care may be equal in terms of health outcomes like
14 control of diabetes and blood pressure and patient satisfaction [17].
15 However, no evidence-based conclusion can be drawn currently with regard to
16 the influence of involving higher qualified non-physician workforce on health
17 care efficacy indicators like hospitalization rate, specialist consultations and
18 costs. Furthermore, common sample sizes of available RCTs may be
19 underpowered to capture effects in this regard. The aim of this study was to
20 assess the influence of involving certified health care assistants on quality and
21 efficacy of primary care in Germany. For this purpose, for the first time a high-
22 volume claims data cross-sectional study was performed.

1 **Methods**

2 Study Design

3 A cross-sectional study was conducted. Claims data related to patients treated
4 in general practices between January 1 and December 31, 2014 were supplied
5 by the AOK statutory health insurance company (German: "Allgemeine
6 Ortskrankenkasse", Baden-Wuerttemberg, Germany). Data of patients treated
7 in practices employing at least one certified HCA were compared to data from
8 practices not employing HCAs (non-HCA) to assess the influence of involving
9 HCAs in primary care delivery. Ethical approval for this study was given by the
10 local institutional Ethics Committee of the University Hospital Heidelberg (No.
11 S-359/2013).

12 Study population

13 Secondary data related to patients insured by the AOK statutory health
14 insurance company of Baden-Wuerttemberg, Germany, and participating in a
15 specific primary care program in Germany (GP-centred care; German:
16 "Hausarztzentrierte Versorgung" (HZV)) were eligible for data analysis. The
17 federal state of Baden-Wuerttemberg has a population of about 10.7 million and
18 AOK is the largest statutory health insurer with about 4 million insured persons.
19 The HZV program is a large-scale, legally stipulated care concept encouraging
20 patients to enroll with a general practitioner (GP), aiming to strengthen primary
21 care and to enhance health care for patients with chronic diseases and complex
22 health care needs [18]. Secondary patient data were included in the analysis, if
23 patients met the following criteria: aged 18 years or older, living in Baden-
24 Wuerttemberg, at least one visit to the primary care physician in the relevant

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3 1 year, no registration with other primary care contracts (e.g., integrated care
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5 2 contracts), no interruptions of registration to HZV program in the relevant year.

6 7 8 3 Intervention

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10 4 Since 2008, practice assistants working in practices participating in the HZV
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12 5 program in Germany, can enhance their professional education by attending a
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14 6 standardized curriculum of 200 teaching units of theoretical and practical
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16 7 lessons. Upon mandatory examination, these practice assistants become state-
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18 8 certified as HCA (German: VERAH) [7]. Besides routine tasks like blood
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20 9 sampling, electrocardiogram recording or spirometry, HCAs are thought to
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22 10 perform monitoring of chronically-ill patients, prevention measures, routine
23
24 11 home visits and wound care management.

25 26 27 28 12 Data acquisition and outcome parameters

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30 13 Secondary patient data were recorded by the AOK state health insurance
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32 14 company for reimbursement purposes and continuous evaluation of the HZV
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34 15 program. For the analysis, data were supplied by the AOK to the Department
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36 16 of General Practice and Health Services Research, University Hospital
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38 17 Heidelberg. Practices employing certified HCAs could be unambiguously
39
40 18 identified since employment of HCAs is obligatorily reimbursed by state health
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42 19 insurance in the HZV program. The claims data consisted of several data sets,
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44 20 containing particular information on patient care (e. g. GP consultations,
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46 21 prescriptions and hospitalizations). These data could be linked on the basis of
47
48 22 a unique patient identifier. Data linkage was performed by our research team
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50 23 using a relational database. Subjects cannot be identified, directly or through
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52 24 identifiers linked to the subjects. Data storage and extraction were performed
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54 25 with MySQL Community Server x64 (Oracle Corporation, Redwood Shores,
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1 CA, USA). All national and institutional guidelines concerning data acquisition
2 for retrospective analyses were followed at all times.

3 The obtained data set comprised age, gender, diagnoses according to ICD-10
4 coding as well as accounting data on consultations, prescribed medication and
5 hospital stays.

6 To assess the effect of involving HCAs on quality and efficacy of primary care,
7 the following outcome parameters were analyzed: GP consultations, specialist
8 consultations, hospital admissions, hospital readmissions within 4 weeks,
9 hospitalization costs, prescription of follow-on drugs and outpatient medication
10 costs. The number of GP and specialist consultations per patient could be
11 determined by the codes according to the EBM system (“Einheitlicher
12 Bewertungsmaßstab”) used for accounting of outpatient medical services in
13 Germany. Number of hospital admissions and readmissions per patient as well
14 as per-patient costs for hospitalization in € was determined by the recorded
15 Diagnosis Related Groups (DRG) codes used for reimbursement of inpatient
16 medical services in Germany. The per-patient number of prescriptions of so-
17 called follow-on drugs, patent-secured marginally altered pharmaceuticals with
18 no benefit compared to the prototype drug according to evidence-based criteria
19 [19], was determined by records of the central pharmaceutical numbers of
20 prescribed medications (“Pharmazentralnummer”, PZN). Outpatient medication
21 costs per patient in € could be determined by accounting data for prescriptions
22 reimbursed by the AOK state health insurance.

23 Statistical analysis

24 The full sample of available claims data was used for the analysis. In order to
25 calculate frequencies, rates and percentages, we used SAS PROC SQL. In

1 order to assess the adjusted outcomes of interest, we used SAS PROC
2 GENMOD (SAS V.9.4×64, SAS Institute). There was no missing data within the
3 underlying data set. If there was no utilization for a particular patient, e.g. no
4 hospitalization, this was denoted as “0”. The following factors were selected ex
5 ante for the adjustment of the comparison between groups: patient age, sex,
6 morbidity according to Charlson Index [20], nursing home as residence, nursing
7 care level (legally defined 4-point scale to assess need for nursing support),
8 urbanization (rural, urban), practice size (number of contacts in relevant
9 period), type of practice (single, group). Comparison between groups was done
10 by multivariable regression analysis, which the three-level clustering of
11 patients, GPs and practices into account. Depending on the distribution of each
12 outcome, linear regression, negative-binomial regression or Poisson
13 regression models (for count data) were used. Since multiple hypotheses were
14 tested in this analysis, the Bonferroni correction was used to compensate for
15 multiple comparisons. For all analyses, results were considered statistically
16 significant, if the p value was 0.05 or less.

17 Patient and public involvement

18 Exploring strategies to provide and maintain access to high-quality primary care
19 is of public interest, particularly in the view of growing prevalence of chronic
20 diseases and limited health care resources. Due to the retrospective study
21 design based on an analysis of pseudonymized data, patients could not be
22 identified, nor be informed or involved into this study. The public dissemination
23 of the results is intended to be achieved by scientific publication.

1 Results

2 861,223 patients were evaluated in the observation period from January 1 to
3 December 31, 2014. 397.493 patients were treated in practices involving at
4 least one HCA to primary care (HCA group), 463.730 patients were seen in
5 practices, which did not employ HCAs (non-HCA group). Patients
6 characteristics are shown in Table 1.

Table 1: Patient characteristics: Data of patients treated in practices employing
at least one HCA compared to practices not employing HCAs (non-HCA)

	HCA	Non-HCA	p
Number of patients	397493	463730	
Male (N, %)	174415 (43.9%)	200775 (43.2%)	<0.0001
Age	56.9 ± 18.5	58.4 ± 18.1	<0.0001
Charlson Index	1.37 ± 2.0	1.38 ± 1.98	<0.0001
Care level [N]			<0.0001
No care:	378919	442024	
I:	11186	13165	
II:	5771	6765	
III:	1593	1751	
IV:	24	25	

Continuous values are presented as mean ± standard deviation; HCA: health care assistant;

7 According to the adjusted analysis, patients in the HCA-group had an 8.2%
8 lower rate of specialist consultations ($p < 0.0001$). Per-patient number of hospital
9 admissions was 4.0% lower ($p < 0.0001$) and number of hospital readmissions
10 was 3.5% lower in the HCA group ($p = 0.0463$). Prescriptions of follow-on drugs
11 were 14.2% lower and total outpatient medication costs were 4.69% lower in
12 the HCA-group respectively ($p < 0.0001$). No difference was found regarding the
13 number of GP consultations and hospitalization costs (Table 2).

Table 2: Outcomes: Outcome parameters for patients treated in practices employing at least one HCA compared to practices not employing HCAs (non-HCA)

Per-patient outcome	Unadjusted Outcome		Adjusted Difference (AD) HCA vs. non-HCA		
	HCA	Non-HCA	AD [95%CI]	AD in %	p
GP consultations	13.46 ± 11.42	13.72 ± 11.81	-0.063 ± 0.021 [-0.105, -0.022]	-0.21%	0.0028
Specialist consultations	4.59 ± 8.23	4.89 ± 8.38	-0.209 ± 0.018 [-0.245, 0.173]	-8.21%	<0.0001
Hospital admissions	0.272 ± 0.762	0.286 ± 0.790	-0.013 ± 0.008 [-0.057, -0.025]	-4.00%	<0.0001
Hospital readmissions	0.210 ± 0.682	0.216 ± 0.721	-0.036 ± 0.018 [-0.071, -0.006]	-3.53%	0.0463
Hospitalization costs [€]	6,239 ± 9,388	6319 ± 9278	-40.42 ± 0.005 [-0.018, 0.003]	0.73%	0.1711
Prescription of follow-on drugs	3.12 ± 10.15	3.57 ± 10.89	-0.388 ± 0.026 [-0.437, -0.334]	-14.2%	<0.0001
Outpatient medication costs [€]	1,333 ± 59,877	1376 ± 51567	-71.01 ± 0.011 [-0.070, -0.026]	4.69%	<0.0001

Values are presented as mean ± standard deviation; AD: adjusted difference; GP: general practitioner;

HCA: health care assistant; CI: confidence interval

1 Discussion

2 For the first time, this cross-sectional study assessed high-volume claims data
3 to evaluate the influence of involving HCAs on quality and efficacy of primary
4 care in Germany. The analysis of care-related data of 861,223 patients showed
5 a lower rate of hospital admissions, specialist consultations as well as lower
6 outpatient medication costs when HCAs were part of the practice staff.
7 Although the measured effect is low-scaled, it is of high relevance for the
8 development of future primary care concepts. From a patient-centered view,
9 avoiding hospitalization or unnecessary medication may help to reduce
10 patients' burden and morbidity due to hospital stay or pharmacological side-
11 effects. On the other hand, avoidable treatment will be not only a central
12 determinant of quality, but a key cost factor for health care systems, which will
13 be challenged by the rising prevalence of chronic diseases in the future.

14 The measured effect may be hypothesized to be due to an improved patient
15 access to primary care. Either directly by being attended to by an HCA, or
16 indirectly by improvement of workflow, patients may benefit from a higher
17 quality and efficacy of care. Hospitalizations and specialist consultations may
18 be avoided by a more intensive outpatient care facilitated by HCA involvement.
19 Particularly, patients with chronic diseases may benefit from extended services
20 like intense monitoring, education and reminders [21]. And eventually, costs for
21 prescriptions may be reduced by efficient management of medication regimen.

22 To date, knowledge about potential effects of involving higher qualified non-
23 physician healthcare professionals in primary care is low. Several RCTs
24 evaluating disease management programs for chronic conditions like chronic
25 pulmonary disease or heart failure involved practice assistants with enhanced

1 educational training and responsibilities, however, did not prove an effect of
2 these programs on relevant care indicators [6,15,22]. A potential reason for
3 this contrast to our findings may be an underpowered sample-size postulating
4 a reduction of avoidable hospitalizations up to 20%. The results of our study
5 show a much smaller effect with a reduction of 4% hospitalizations when HCAs
6 were involved, which in our opinion is closer to reality in primary care. As a
7 comparison, even in settings of complex disease management programs for
8 heart failure patients, low rates of reduction in all-cause hospitalization are
9 common when involving academically educated non-physician work forces and
10 specialist physicians, with a range of up to 8% as a recent meta-analysis of 12
11 RCTs showed [23].

12 Another relevant finding of this study is that the rate of GP consultations was
13 only slightly reduced by 0.21% when HCAs were involved. This is noteworthy,
14 since a distinct reduction of GP consultations might have been expected
15 assuming that HCAs perform chosen routine tasks independently. On the
16 other hand, this result may reflect that involvement of HCAs is not implemented
17 as a one-way delegation or as a substitution for physician care as has been
18 proposed for nurse-led care concepts [17], but more as a team interaction.
19 However, no conclusion can be drawn by this study with regard to the specific
20 role of HCAs within the practice staff. As a recent survey showed, in Germany
21 there is no firmly standardized professional role for HCAs. Performed tasks
22 differ widely from simple patient assessment or basic wound care to tasks with
23 substantial responsibility like emergency home visits, chronic care
24 management or treatment of complex wounds [7]. Eventually, the GP decides
25 which tasks are performed by HCAs and to what extent they perform them

1 independently. While this approach meets individual eligibility, more
2 standardization may be favourable to identify tasks to be shared in teams
3 according to their effect on care quality and efficacy. Furthermore, it could help
4 to reveal potential limitations, as found in nurse-led self-management programs
5 of COPD, which have been associated with higher airway-related mortality
6 [15,24]. A promising approach for a standardized involvement of HCAs certainly
7 lies in chronic disease management programs, which proved to be efficient for
8 heart failure or asthma bronchiale [23,25,26]. Furthermore, patient monitoring
9 by HCAs could be supported using new IT-based methods such as web-based
10 telemedical care, which has been shown to prevent hospital admissions and
11 reduce all-cause mortality in heart failure patients [27]. Finally, involving HCAs
12 in standardized translational approaches after hospital release may be
13 promising to reduce readmission rates [28,29].

14 Limitations are given by the study design and the associated risk of confounding
15 factors. Due to the nature of claims data, the parameters available for analysis
16 were limited. The omission of practice details was an important element of the
17 data protection contract for participating practices with the objective not to be
18 identifiable by researchers. Thus, further potentially relevant factors such as
19 educational level and experience of the staff or structural characteristics of the
20 practices like equipment or procedural factors such as available diagnostics
21 and treatment options, were not available for this analysis. Furthermore, the
22 evaluation of relevant patient-reported outcomes such as quality of life was not
23 possible in this analysis. On the other hand, we deliberately chose claims data
24 for this analysis due to the high volume and statistical power necessary to
25 assess the chosen outcomes. Furthermore, in our opinion the available

1 structural factors included in this analysis represent an appropriate and best
2 possible adjustment for the measured outcomes.

3 This high-volume cross-sectional study showed that involving HCAs in primary
4 care in Germany is associated with a reduction in hospital admissions,
5 specialist consultations and overall medication costs. Consequently,
6 broadening qualifications and responsibilities of non-physician work forces may
7 be a successful strategy not only to alleviate physicians' workload, but to
8 improve quality and efficacy of primary care to meet future health care
9 challenges. Further studies should explore specific tasks to be shared with non-
10 physician workforces and standardization of the professional role.

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Contributors

3 Jonas D. Senft: design and methods, writing the article; Regina Poss-Doering:
4 data interpretation, revision of the article; Michel Wensing: data interpretation,
5 revision of the article; Joachim Szecsenyi: design and methods, revision of the
6 article; Gunter Laux: design and methods, statistical analysis, revision of the
7 article. All authors commented on the draft and approved the final version of
8 the manuscript.

Competing interests

9 The authors Jonas D. Senft, Regina Poss-Doering, Michel Wensing, Joachim
10 Szecsenyi and Gunter Laux have no competing interests or financial ties to
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Data sharing statement

16 Data used in this analysis are not in the public domain and use is covered by
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References:

1. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Arch Intern Med.* 2002;162: 2269–2276. doi:10.1001/archinte.162.20.2269
2. Fried TR, Tinetti ME, Iannone L. Primary care clinicians' experiences with treatment decision making for older persons with multiple conditions. *Arch Intern Med.* 2011;171: 75–80. doi:10.1001/archinternmed.2010.318
3. Zolnierok KBH, Dimatteo MR. Physician communication and patient adherence to treatment: a meta-analysis. *Med Care.* 2009;47: 826–834. doi:10.1097/MLR.0b013e31819a5acc
4. Kelley JM, Kraft-Todd G, Schapira L, Kossowsky J, Riess H. The influence of the patient-clinician relationship on healthcare outcomes: a systematic review and meta-analysis of randomized controlled trials. *PLoS ONE.* 2014;9: e94207. doi:10.1371/journal.pone.0094207
5. Ghorob A, Bodenheimer T. Sharing the care to improve access to primary care. *N Engl J Med.* 2012;366: 1955–1957. doi:10.1056/NEJMp1202775
6. Freund T, Peters-Klimm F, Boyd CM, Mahler C, Gensichen J, Erler A, et al. Medical Assistant-Based Care Management for High-Risk Patients in Small Primary Care Practices: A Cluster Randomized Clinical Trial. *Ann Intern Med.* 2016;164: 323–330. doi:10.7326/M14-2403
7. Mergenthal K, Beyer M, Gerlach FM, Guethlin C. Sharing Responsibilities within the General Practice Team - A Cross-Sectional Study of Task Delegation in Germany. *PLoS ONE.* 2016;11: e0157248. doi:10.1371/journal.pone.0157248
8. Freund T, Everett C, Griffiths P, Hudon C, Naccarella L, Laurant M. Skill mix, roles and remuneration in the primary care workforce: who are the healthcare professionals in the primary care teams across the world? *Int J Nurs Stud.* 2015;52: 727–743. doi:10.1016/j.ijnurstu.2014.11.014
9. Donald F, Martin-Misener R, Bryant-Lukosius D, Kilpatrick K, Kaasalainen S, Carter N, et al. The primary healthcare nurse practitioner role in Canada. *Nurs Leadersh (Tor Ont).* 2010;23 Spec No 2010: 88–113.
10. Lukewich J, Edge DS, VanDenKerkhof E, Williamson T, Tranmer J. Association between registered nurse staffing and management outcomes of patients with type 2 diabetes within primary care: a cross-sectional linkage study. *CMAJ Open.* 2016;4: E264-270. doi:10.9778/cmajo.20150113
11. Russell GM, Dahrouge S, Hogg W, Geneau R, Muldoon L, Tuna M. Managing chronic disease in ontario primary care: the impact of

- 1
2
3 1 organizational factors. *Ann Fam Med*. 2009;7: 309–318.
4 2 doi:10.1370/afm.982
5
6 3 12. Halter M, Drennan V, Chattopadhyay K, Carneiro W, Yiallourous J, de
7 4 Lusignan S, et al. The contribution of physician assistants in primary care:
8 5 a systematic review. *BMC Health Serv Res*. 2013;13: 223.
9 6 doi:10.1186/1472-6963-13-223
10
11 7 13. Ruggiero L, Riley BB, Hernandez R, Quinn LT, Gerber BS, Castillo A, et
12 8 al. Medical assistant coaching to support diabetes self-care among low-
13 9 income racial/ethnic minority populations: randomized controlled trial.
14 10 *West J Nurs Res*. 2014;36: 1052–1073. doi:10.1177/0193945914522862
15
16 11 14. Bekelman DB, Plomondon ME, Carey EP, Sullivan MD, Nelson KM,
17 12 Hattler B, et al. Primary Results of the Patient-Centered Disease
18 13 Management (PCDM) for Heart Failure Study: A Randomized Clinical
19 14 Trial. *JAMA Intern Med*. 2015;175: 725–732.
20 15 doi:10.1001/jamainternmed.2015.0315
21
22 16 15. Fan VS, Gaziano JM, Lew R, Bourbeau J, Adams SG, Leatherman S, et
23 17 al. A comprehensive care management program to prevent chronic
24 18 obstructive pulmonary disease hospitalizations: a randomized, controlled
25 19 trial. *Ann Intern Med*. 2012;156: 673–683. doi:10.7326/0003-4819-156-10-
26 20 201205150-00003
27
28 21 16. Connor KI, Cheng EM, Barry F, Siebens HC, Lee ML, Ganz DA, et al.
29 22 Randomized trial of care management to improve Parkinson disease care
30 23 quality. *Neurology*. 2019;92: e1831–e1842.
31 24 doi:10.1212/WNL.0000000000007324
32
33 25 17. Laurant M, van der Biezen M, Wijers N, Watananirun K, Kontopantelis E,
34 26 van Vught AJ. Nurses as substitutes for doctors in primary care. *Cochrane*
35 27 *Database Syst Rev*. 2018;7: CD001271.
36 28 doi:10.1002/14651858.CD001271.pub3
37
38 29 18. Laux G, Kaufmann-Kolle P, Bauer E, Goetz K, Stock C, Szecsenyi J.
39 30 [Evaluation of family doctor centred medical care based on AOK routine
40 31 data in Baden-Württemberg]. *Z Evid Fortbild Qual Gesundheitsw*.
41 32 2013;107: 372–378. doi:10.1016/j.zefq.2013.07.001
42
43 33 19. Fricke U, Hein L, Schwabe U. *Neue Arzneimittel 2016*. In: Schwabe U,
44 34 Paffrath D, Ludwig W-D, Klauber J, editors. *Arzneiverordnungs-Report*
45 35 2017. Berlin, Heidelberg: Springer Berlin Heidelberg; 2017. pp. 55–135.
46 36 doi:10.1007/978-3-662-54630-7_3
47
48 37 20. Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA.
49 38 New ICD-10 version of the Charlson comorbidity index predicted in-
50 39 hospital mortality. *J Clin Epidemiol*. 2004;57: 1288–1294.
51 40 doi:10.1016/j.jclinepi.2004.03.012
52
53
54
55
56
57
58
59
60

- 1
2
3 1 21. Freund T, Mahler C, Erler A, Gensichen J, Ose D, Szecsenyi J, et al.
4 2 Identification of patients likely to benefit from care management programs.
5 3 Am J Manag Care. 2011;17: 345–352.
6
7
8 4 22. Siebenhofer A, Ulrich L-R, Mergenthal K, Berghold A, Pregartner G,
9 5 Kemperdick B, et al. Primary care management for patients receiving
10 6 long-term antithrombotic treatment: A cluster-randomized controlled trial.
11 7 PLoS ONE. 2019;14: e0209366. doi:10.1371/journal.pone.0209366
12
13 8 23. Takeda A, Martin N, Taylor RS, Taylor SJ. Disease management
14 9 interventions for heart failure. Cochrane Database Syst Rev. 2019;1:
15 10 CD002752. doi:10.1002/14651858.CD002752.pub4
16
17
18 11 24. Lenferink A, Brusse-Keizer M, van der Valk PD, Frith PA, Zwerink M,
19 12 Monninkhof EM, et al. Self-management interventions including action
20 13 plans for exacerbations versus usual care in patients with chronic
21 14 obstructive pulmonary disease. Cochrane Database Syst Rev. 2017;8:
22 15 CD011682. doi:10.1002/14651858.CD011682.pub2
23
24
25 16 25. Smith SM, Soubhi H, Fortin M, Hudon C, O'Dowd T. Interventions for
26 17 improving outcomes in patients with multimorbidity in primary care and
27 18 community settings. Cochrane Database Syst Rev. 2012; CD006560.
28 19 doi:10.1002/14651858.CD006560.pub2
29
30
31 20 26. Peytremann-Bridevaux I, Arditi C, Gex G, Bridevaux P-O, Burnand B.
32 21 Chronic disease management programmes for adults with asthma.
33 22 Cochrane Database Syst Rev. 2015; CD007988.
34 23 doi:10.1002/14651858.CD007988.pub2
35
36 24 27. Koehler F, Koehler K, Deckwart O, Prescher S, Wegscheider K, Kirwan
37 25 B-A, et al. Efficacy of telemedical interventional management in patients
38 26 with heart failure (TIM-HF2): a randomised, controlled, parallel-group,
39 27 unmasked trial. Lancet. 2018;392: 1047–1057. doi:10.1016/S0140-
40 28 6736(18)31880-4
41
42
43 29 28. Hesselink G, Schoonhoven L, Barach P, Spijker A, Gademan P, Kalkman
44 30 C, et al. Improving patient handovers from hospital to primary care: a
45 31 systematic review. Ann Intern Med. 2012;157: 417–428.
46 32 doi:10.7326/0003-4819-157-6-201209180-00006
47
48 33 29. Braet A, Weltens C, Sermeus W. Effectiveness of discharge interventions
49 34 from hospital to home on hospital readmissions: a systematic review. JBI
50 35 Database System Rev Implement Rep. 2016;14: 106–173.
51 36 doi:10.11124/jbisrir-2016-2381
52
53
54 37
55
56 38
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	9
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
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	9
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10
		(b) Describe any methods used to examine subgroups and interactions	10
		(c) Explain how missing data were addressed	n/a
		(d) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(e) Describe any sensitivity analyses	10
Results			

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	11
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	15*	Report numbers of outcome events or summary measures	12
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	12
		(b) Report category boundaries when continuous variables were categorized	n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
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	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	17

*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.