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Benefits of medication charts provided at transitions of care: a narrative systematic review

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ABSTRACT

Objectives Particularly at transitions of care points information concerning current medication tends to be incomplete. A medication chart that contains all essential information on current therapy is likely to be a helpful tool for patients and healthcare providers. We aimed to investigate any type of benefits associated with medication charts provided at transition points.

Methods A systematic review according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines was performed. Two databases, two online journals and two association websites dedicated to biomedicine and pharmacy issues were consulted to identify studies for the review using the search term 'medication chart' and synonyms. We run our search from database inception up to March 2019. Studies of any study design, intervention and population which examined the effect of paper-based medication charts were included. We extracted study results narratively and coded and classified them by themes and categories inductively by using the 'framework method' with content analysis. The methodological quality of the studies was assessed using the Effective Public Health Practice Project (EPHPP) tool.

Results From the 846 retrieved articles, 30 studies met the inclusion criteria, mostly from Germany (18 studies) and the USA (5 studies). Thirteen studies reported a statistically significant result. In the 'patient theme', the most obvious benefits were an increase in medication knowledge, a reduction of medication errors and higher medication adherence. In the 'interdisciplinary theme', a medication chart represented a helpful tool to increase communication and inter-sectoral cooperation between healthcare providers. In the 'theme of terms and conditions', accuracy and currency of data are prerequisites for any positive effect. The quality of the studies was classified predominantly weak mainly due to unmet good quality criteria (no randomised controlled trials study design, no reported dropouts).

Conclusion Overall, the reviewed studies suggested some benefits when using medication charts. Healthcare providers could consider using medication charts in their counselling practice. However, it is unknown whether the reported benefits lead to measurable improvement in clinical outcomes.

PROSPERO registration number

Strengths and limitations of this study

- The use of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis and the Effective Public Health Practice Project tool to evaluate the methodological quality of each included study.
- First review that highlights the benefits of medication charts.
- It is possible that we missed studies because we did not include studies written in other languages than English or German.
- Due to the narrative nature of the data, it was not possible to perform a meta-analysis of the included studies.
- The overall quality of the included studies was weak.

INTRODUCTION

In most countries, prescribing of medications is split between standard paper prescriptions and electronic prescribing software systems.[1] After filling their prescriptions, patients may receive written information such as product name, strength, dose frequency and additional information that is required on dispensing labels that are affixed on medication or medication containers. Further information might be already present on the package, such as indication, expiration date or storage temperature.[2]

In this review, a medication chart is a paper document that lists all of the patient's current medications that is, prescribed and over the counter medications. It is intended to be handed over to the patient as hardcopy and conveys information to patients and healthcare professionals (eg, doctors, nurses, physiotherapists, dentists) at transitions of care.[3] Other terms are used in different countries such as medication schedule[4] or personal medication list.[5]

Effectively, patients seldom obtain a medication chart, although the number of patients with a complex medication regimen is rising.[6 7] Every fifth patient is reported as polymedicated, which is generally recognised as a patient using five or more medications on a daily basis.[8 9] The prevalence of polymedication among the population older than

65 years ranges from 26.3% in Switzerland to 52.7% in Spain.[10 11] Consequently, a medication chart could be considered a helpful tool for patients using multiple medications.[12]

It has been suggested that correct documentation of medications can play a crucial role in patient care, especially for the continuity of medications at care transitions.[13 14] Across studies, deviations between medications on file and actually taken are reported to be present for 75%–89% of patients in the ambulatory setting.[15–17] Unintentional discrepancies have been shown to lead to poorer subjective well-being, predominantly concerning the mood,[17] increased risk of hospital utilisation within 30 days after discharge especially for older people[18] and additional medication errors, mainly omission of a regular taken medication.[14] However, the impact of medication charts is still unknown.

A medication chart should optimally represent a permanent historical and current record of all prescribed and over the counter medications. The chart should contain at least the information on active ingredients, dosage, indication and special instructions.[19] Usually, a medication chart is distributed to the patient as a hardcopy at transitions of care.[20] However, the use of electronic medication charts in the ambulatory setting is appearing such as in Germany with a national standardised medication chart ('bundeseinheitlicher Medikationsplan').[19] A 2D data code is printed on the chart, which can be scanned and used in medical practices, pharmacies or hospitals.

The benefit of a medication chart seems intuitive. However, we found no systematic review in this area. Our review aims to evaluate the benefits of paper-based medication charts for patients and healthcare providers in daily practice.

METHODS

Search strategy

This review follows Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for the reporting of systematic reviews.[21] PubMed and Web of Science were searched for papers published in English or German, using a search strategy with synonyms of 'medication chart' (see supplemental A for the complete search string). We run our search from database inception up to March 2019.

Additionally, the websites of the WHO (www.who.int), ABDA (Bundesvereinigung Deutscher Apothekerverbände) (Federal Union of German Associations of Pharmacists: www.abda.de) and the professional newspapers PZ (Pharmaceutical newsletter: www.pharmazeutische-zeitung.de) and DAZ (Newsletter for pharmacists: www.deutsche-apotheker-zeitung.de) were screened for relevant publications, as a depository of grey literature dedicated to biomedicine and pharmacy issues. We also searched references of retrieved articles.

Inclusion and exclusion criteria

A study was included if a medication chart and its practical application were explored, independently of study design and intervention. Articles, which focused on a specific population (eg, children) or indication (eg, diabetes disease), and papers focusing solely on the development or electronic version of medication charts were excluded. Although electronic medication charts are increasingly being used, we have focused on the content and benefits of the chart rather than the method of transmission. Therefore, only articles that examine paper-based plans were included in this review. All hits of the search were transferred to EndNote V.X9 and freed from duplicates. One author (FMD) examined the titles of the papers and excluded irrelevant papers. The abstract of the remaining articles was then screened. A random sample of 10% of the hits was reviewed by a second author (IA) for quality verification. FMD and IA independently reviewed the full text of the articles for final inclusion. The discrepancy was solved by discussion until consensus was obtained.

Data extraction and quality assessment

Two coauthors (IA and FMD) independently extracted the following study characteristics: first author name, year of publication, study design, population, method, aim, study results, benefits of medication charts and statistical significance (p value) if present.

Study quality was measured using the EPHPP assessment tool.[22 23] Each study was rated as 'strong', 'moderate' or 'weak' by evaluating the strength of five quality criteria: selection bias, study design, confounders, data collection methods, withdrawals/dropouts. The criterion blinding was not assessed because studies were inherently designed as open. A study was classified as 'strong' when no criterion was rated as weak; as 'moderate' when only one weak criterion was identified, and as 'weak' when more than one weak criterion was identified. The quality assessment was carried out independently by two coauthors (IA and FMD), the consensus was reached by discussion.

Data analysis

The individual results of the retrieved studies were predominantly of a descriptive nature. Thus, we chose a method of qualitative research to analyse the data, that is the 'framework method'.[24] This methodology involves five stages to collect and analyse data. Stage 1 (transcription) was omitted as the result section of the retrieved studies were considered as transcripts. After familiarisation of the raw data (stage 2), an analytical framework was identified (stage 3) from the emerging themes, and categories were developed, all linked to positive results that is, benefits of using medication charts. Open coding (stage 4) was then performed in an inductive manner by applying the framework to the data and labelling in order to capture a crucial concept. Additional codes were identified, which allowed for the development of the framework. Each study was coded across all categories. A codebook was developed to ensure understanding of the categories (table 1). Finally,

Table 1 Codebook with definitions of themes, categories and populations

Themes	
Patient	A person who is receiving, has received or has requested healthcare[73]
Process	The act of prescribing and administering medication by health experts
Terms and conditions	Necessary requirements (in form and content) to create and work with medication charts
Categories	
Knowledge	Patients' understanding of his/her medical treatment (factual knowledge)
Safety	Medication safety (freedom from preventable harm with medication use) and patient safety (reduction of unsafe acts within the healthcare system, as well as the use of best practices shown to lead to optimal patient outcomes)[73]
Purpose	The function or aim that a medication chart is fulfilling for someone
Communication	Verbal interaction between patient and healthcare provider
Empowerment	Patients' individual belief in his/her own capabilities to execute courses of actions in order to achieve health-related goals[74]
Interdisciplinary cooperation	The degree to which healthcare providers are networked and interact within their professions (including communication, co-working and information exchange)[74]
Resources	Management of finances, income and expenditure
Prescription	A written directive to dispense and administrate medications to a particular patient
Patient files	A document or a collection of documents, which contain demographic, medical and treatment information about a patient
Populations	
Physicians/pharmacists/hospital	Anyone of the following healthcare providers: physicians, pharmacists, nurses, medical or pharmaceutical assistant
Patients ambulant/nursing home	Any patient who is treated in outpatient care (including diagnosis, observation, consultation, treatment, intervention and rehabilitation services) or stayed in a residential facility[75]
Patients hospitalised/discharged	Any patient who stayed in a hospital (ie, inpatient facilities for 24-hour medical and nursing care) or recently terminated such a stay[75]
Citizens	Any individual who was present in a certain precinct and participated in a survey

all codes were rearranged and summarised (stage 5) in a thematic matrix.[25] This 'framework method' allows for the analysis of the data both across the studies and within the themes.[26] In addition, conventional content analysis was performed that is, we quantified the codes assigned to labelled texts[27] in order to assess the proportion of patterns in the data. We present results of both qualitative and quantitative nature summarised within themes and categories.

RESULTS

Study selection

A total of 846 articles were identified (figure 1). After deleting 122 duplicates, a further 553 studies were excluded by screening the title. The remaining 171 articles were screened through their abstract and 60 were read as full-text. Thirty met the inclusion criteria. See online supplemental B for the PRISMA Checklist.

Study characteristics

The majority of the included studies originated from Germany (18/30 studies, 60%), followed by the USA (5), Australia (3), UK (2), Ireland (1) and Switzerland (1). Study designs (by decreasing order of evidence[28]) were: 1 systematic review,[29] 4 randomised controlled trials (RCT),[30–33] 10 cohort studies,[34–43] 7 cross-sectional studies,[5 44–49] 2 qualitative evaluations,[4 50] 4 surveys[51–54] and 2 reports.[55 56] Thirteen studies reported statistically significant results with the use of medication charts. The quality was rated as 'strong' for 2 studies,[30 31] as 'moderate' for 5 studies[32 33 35 37 42] and as 'weak' for 21 studies. It was impossible to assess the quality for two reports. See supplement C for the characteristics of all 30 studies.

Framework and content analysis

The distribution of the studies between categories, methodological quality and significance of study results are shown in figure 2. As the result of the framework analysis, four study populations were defined: 'physicians/pharmacists/hospital' (13 studies), 'patients ambulant/nursing home' (15), 'patients hospitalised/discharged' (6) and 'citizens' (1). The data were labelled with 69 codes, which were grouped in three themes and nine categories: 'patient' (five categories: knowledge, safety, purpose, communication and empowerment); 'process' (four categories: interdisciplinary cooperation, resources, patient files and prescription) and 'terms and conditions' with no further categories.

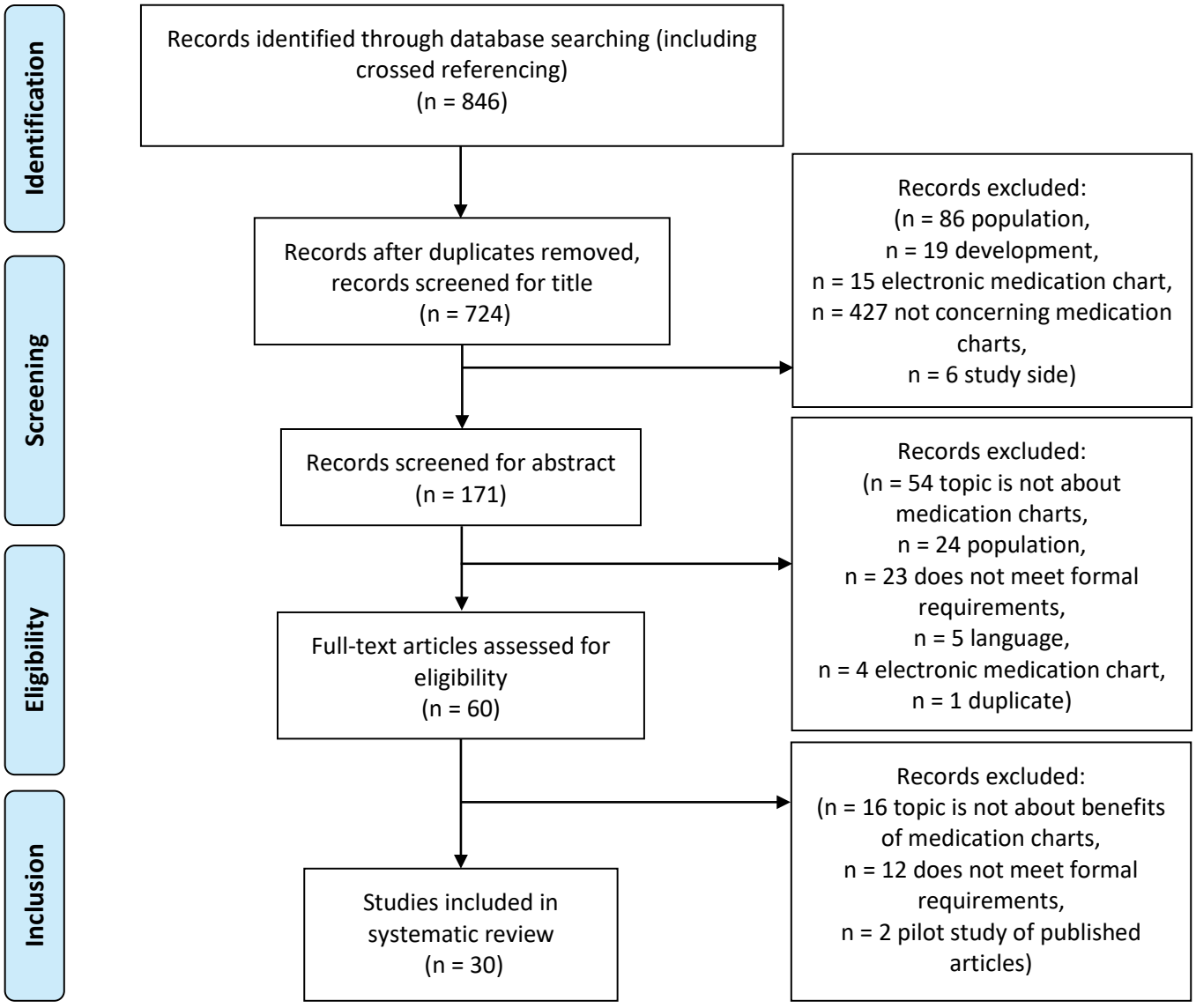

Figure 1: Flow diagram of the study selection according to PRISMA guidelines [21]

Figure 1 Flow diagram of the study selection according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[21]

Theme 1: 'patient'

From the total 69 codes, 51 (74%) were assigned to the theme 'patient'. They concerned mainly ambulant/nursing home patients (23/51, 45%) and knowledge (18/51, 35%). Twenty-four studies (24/30, 80%) investigated the theme 'patient'. Two studies with strong[30 31] and three studies with moderate[32 33 42] methodological quality investigated patients' knowledge. Fifty per cent (6/12) of the statistically significant results were observed in the category knowledge[30 32–34 38 41] (see online supplemental D for the corresponding matrix). Patients with access to a medication chart had a better knowledge of their medication that concerned knowledge of indication,[30 33 34 36 41 42 46 51 53] medication name,[34 38 46] dosage[31 32 34 46 51 53] and dosage frequency.[30–32 46] The increase in knowledge was reported by means of patients who answered all questions correctly

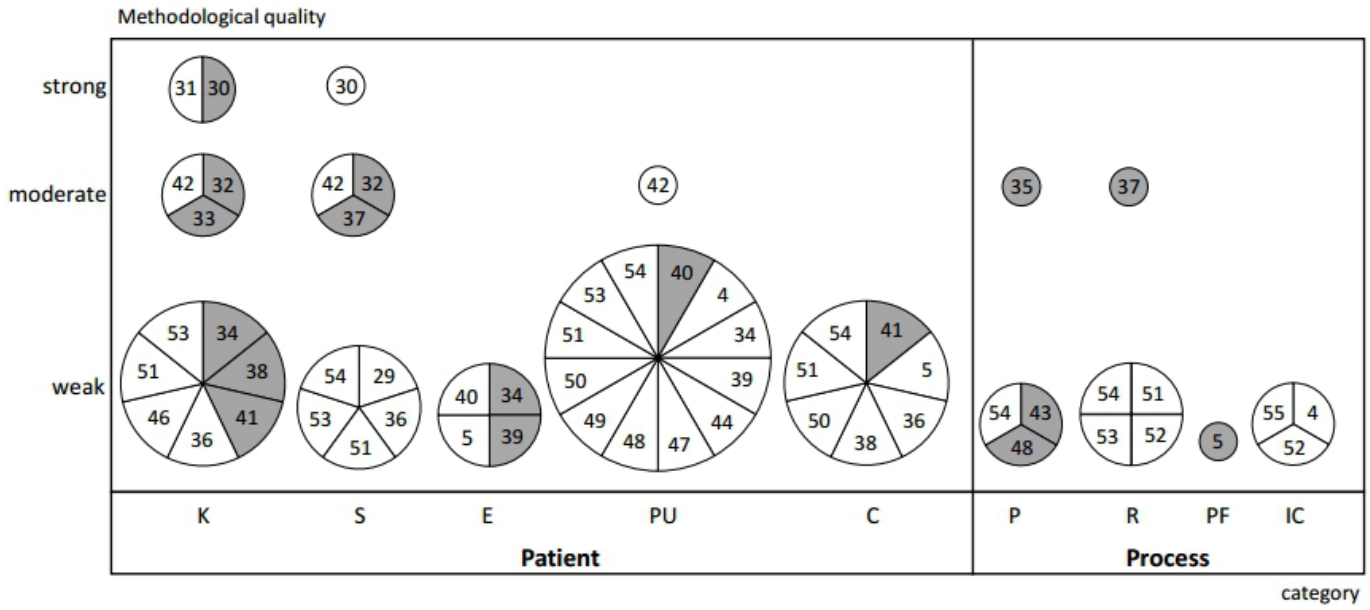

Figure 2 Distribution of the 30 studies between the themes 'patient' and 'process' and per category according to the methodological quality (weak, moderate, strong). Each study is represented as a pie segment (reference number), grey-shaded segments point out statistically significant study results (p<0.05). The larger the pie, the larger the number of studies reporting on that category. C, communication; E, empowerment; IC, interdisciplinary cooperation; K, knowledge; P, prescription; PF, patient file; PU, purpose; R, resources; S, safety.

as follows (intervention group vs control group): 83% (81/98) vs 47% (47/99; p<0.001),[32] 66% (48/73) vs 35% (37/106; p<0.001),[38] 60% (24/40) vs 17.9% (5/28; p=0.001).[41] Similarly, using medication charts increased perceived knowledge (p=0.049),[34] or was associated with the ability to provide correct information (OR 2.21).[46] Finally, the number of correctly answered questions increased by 23.2% (baseline 56/138; follow-up 88/138) compared with the control group (baseline 55/123; follow-up 58/126; p<0.01).[33]

In the systematic review on safety-relevant indicators, a medication chart was identified as one out of 14 parameters to ensure medication safety as well as patient safety.[29] Over 80% of the patients (N=138) in an RCT indicated that the medication chart helped them 'avoid making mistakes with medications' that were further described as medication intake errors such as wrong time, wrong pill or missed pill.[30] Another study measured a significant reduction of missed or delayed medication doses per patient after the implementation of a medication chart at discharge from hospital to nursing homes (from 37/202; 18.3% missed or delayed doses, to 6/226; 2.7%, p<0.001).[37] One-third of physicians and pharmacists (11/34; 32.4%) stated in a survey that a medication chart allowed them to detect contraindications, adverse drug events and medication errors in every fifth patient.[36] Medication adherence, measured by pill count, increased from 86% without a medication chart (N=99) to 93% with a medication chart (N=98, p<0.001).[32] The majority of patients (71/103, 68.9%) mentioned that they felt safer in the handling of their medical treatment when using a medication chart.[51] The purpose of a medication chart was referred as a reminder aid,[4 39 54] a documentation tool[47–49 54] and a source of information.[34 54] The medication chart was further described as a support for transferring written information into practice (ie, preparing a pillbox).[42 44 51 53] In six studies it was suggested that the medication chart represented an important tool for a structured counselling interview between a patient and a physician or pharmacist.[5 36 38 41 50 51] The time spent on individual medications increased significantly when using a medication chart by 61.7% (from 2.13 min (N=50) to 3.18 min (N=40), p=0.02).[41] The amount of overall information on medications and medication application given to patients increased significantly by using a medication chart (151/201 drugs, 75.1% without vs 176/208, 84.6% with medication chart, p=0.017).[41] When generating a medication chart, 58.3% of the surveyed physicians (21/36) conducted additional counselling with their patients.[36] Empowerment of the patient was the only category that was solely reported by one population (patients ambulant/nursing home). One study reported quantitatively that patients have less concerns (p<0.01) and increased perceived necessity of their medication (p<0.01) when they possess a comprehensive medication chart.[39] It further gave patients a more active role[40] and made them feel more responsible for their medical treatment.[5 34]

Theme 2: 'process'

From the total 69 codes, 13 (19%) were assigned to the theme 'process'. They were reported by the two populations 'physicians/pharmacists/hospital' and 'citizens' (see online supplemental E for the corresponding

matrix). Healthcare providers rated the medication chart as very important (21/28, 75%) or important (7/28, 25%) to improve communication and interdisciplinary cooperation.[51] The majority of surveyed physicians (7/10, 70%) and pharmacists (7/8, 88%) stated that with a medication chart they learnt more about medications and diagnoses from other physicians or specialists.[52] No economic benefit was measured, but healthcare providers expected time and money savings once the medication chart was integrated in patient care.[52] Healthcare providers rated the medical treatment as more appropriate (22/28, 78.6%) according to guidelines when a medication chart was available.[51] Patient files were more likely to be accurate and up-to-date with the implementation of a medication chart (328/596, 55% correct files before and 429/594, 72% after implementation, p<0.001).[5] With a medication chart, the number of patients who were receiving medications to which they had a previous adverse drug reaction decreased by 59% (from 21/185 patients (11.3%), to 9/197 patients (4.6%), p=0.021).[35] Furthermore, the continuity of medication management was increased when a medication chart was available at hospital admission (medications continued at hospital admission: 197/493, 40% without vs 799/1510, 53% with medication chart, p<0.001).[43] At hospital admission, the number of missing doses of the current treatment decreased from 2.35 to 0.24 (p<0.05) per patient after implementing medication charts.[48]

Theme 3: 'terms and conditions'

From the total 69 codes, 5 (7%) were assigned to the theme 'terms and conditions', for example the possession of a medication chart and its active use being a prerequisite to any benefit.[46] Two studies concluded that just the delivery of a medication chart to a patient is not sufficient to improve medication safety.[44 54] It is also essential to inform the patient about how to use the medication chart and why it is needed.[54] Further, it has been suggested that a medication chart has to be accurate, up-to-date and comprehensive to achieve the benefits.[44 56] One study observed that only 6.5% (26/399) of the available charts were free of discrepancies. At least one prescription medication was missing on every second medication chart according to that study.[49] It was reported that laboratory values such as international normalised ratio (INR) helped to have the measured values under control when documented on the chart. INR values>5 decreased by 23% (from 1.9%, N=14 405 INRs, to 1.45%, N=15 090 INRs) after implementation of a medication chart (p=0.004).[35]

DISCUSSION

The 'framework method' was used to analyse the results of 30 studies as it enables a thematic analysis of qualitative data and has been previously used in studies with diaries.[57] We identified commonalities and differences in data after grouping codes around themes. The output was a matrix with rows and columns that define cells of summarised data. Within a matrix, the single result remains connected to other aspects so that the context is not lost. Thus, we generated a descriptive overview of the entire data sets and comparison within cells as well as across cells was easy.

This study highlights a wide range and number of potential benefits when using medication charts in daily practice, concerning the themes 'patients', 'process' and 'terms and conditions'. Unsurprisingly, a medication chart is seen by patients and healthcare providers as an essential source of information and knowledge regarding individual medication. Specifically, for patients, a medication chart represents an additional reminder aid and provides support for communication with healthcare providers. For healthcare providers, a medication chart improves the quality of their own records and interdisciplinary cooperation. However, in order for patients with polypharmacy to benefit from a medication chart, accuracy and currency of data were of utmost importance.

Most statistically significant results were observed in the category 'knowledge', although its definitions varied considerably between studies. There were various different methods for measuring knowledge used in the retrieved studies, such as an Evaluation Tool to quantify comprehension of the medication chart.[44] However, in some papers knowledge, a very complex concept, was measured using not validated or reliable simple instruments such as open questions in a structured phone interview.[30] Nevertheless, the benefit of a medication chart on patients' knowledge has been recognised by both, physicians and pharmacists, as demonstrated in prospective studies.[53]

Medication adherence, measured by pill counting, increased from 86% to 93% for patients with a medication chart compared with patients without.[32] This assessment method has several advantages (eg, cheap, easy, objective), and a main disadvantage that is, an empty pill bottle can fake a regular intake and is inclined to manipulation.[58] Nevertheless, a statistical significant increase was observed, but no clinical significance. Thus, we postulate that increased medication adherence may be a result of higher knowledge about medications as this has been suggested in other studies.[59 60]

Another benefit reported with the use of medication charts were medication safety and patient safety, which represented the third most frequent category (9 studies) of benefits after knowledge and purpose (12 studies each). Since no gold standard exists to measure medication safety or patient safety, indirect methods and surrogate indicators of safety issues were reported, such as rate of medication errors or adverse events. Conversely, it has been reported that a higher rate of adverse drug reactions is apparent when using an inaccurate medication chart.[61] The percentage of accurate medication charts has been estimated at 6.5%.[49] Reasons for this alarmingly low rate include lacking information on over-the-counter medication; insufficient communication between

different healthcare settings or multiple physicians; and no regular update of the medication chart.[15 62] To reduce discrepancies, actions have been recommended such as regular medication reconciliations, and improving interprofessional communication as well as documentation of current medication.[15 17 62]

We could find moderate evidence in favour of medication charts avoiding medication errors and adverse events.[30 35 36 53] These issues are important since the current situation regarding patient safety is alarming with adverse drug reactions and/or medication errors being the reason for admission to the emergency department for one out of five patients.[63]

A benefit only reported qualitatively and anecdotally was improved interdisciplinary cooperation. It is noteworthy that physicians and pharmacists mentioned it independently. Similar results are reported in other types of investigations where the success of a therapy increased when physicians and pharmacists worked in structured teamwork.[64 65]

The documentation of patients' medication appears to be crucial at any transition of care (eg, entry or discharge from hospital) and at any change of treatment (prescribing or deprescribing) to avoid medication errors, and eventually improve and ensure safety. The major proviso is that the medication charts are accurate, up to date and comprehensive.

The medication chart is already integrated in several official recommendations such as the national guideline for chronic heart failure[66] or a WHO guideline on patient safety.[67] However, there are various suggestions on how to improve the inclusion of medication charts in daily practice. The WHO suggests to motivate every patient to carry their medication chart with them at any time. The WHO also proposes to include information on allergies on the chart.[67] Another suggestion is to establish two different versions of the medication chart, one for the patient written in a simplified language (eg, indication: heart weakness) and one for the healthcare providers with more detailed information (eg, indication: chronic heart failure).[36] Another promising project currently tested in Bavaria, Germany, is the 'Electronic Medication Plan Plus' which aims to make the medication chart available for the emergency team at the accident location.[36 68]

Study quality

The EPHPP tool, an instrument developed to appraise and synthesise evidence for clinical practice, can be used for any public health intervention and has been developed to support the decision-making process in primary care.[69] However, the appraisal criteria depend largely on the type of study and the risk of bias, following the concept of evidence-based medicine.[70] The quality of our 30 retrieved studies was heterogeneous and predominantly weak. Only four randomised, controlled trials and one cohort study were of high or moderate quality. As blinding is not possible in the context of medication chart studies, we excluded it from the EPHPP criteria. Therefore, we did not prioritise the results according to study quality and all the benefits are presented with the same importance. Whereas the results of the included quantitative studies were surely weak, the qualitative data that we analysed in this review provide more robust evidence of our findings. Therefore, the evidence for the findings of our study can be claimed as moderate.

Strengths and weaknesses of the study

This narrative systematic review has several strengths. First, this review highlights the benefits of medication charts in daily practice and therefore adds valuable information for current and further research. Second, we assessed the methodological quality of our retrieved studies by using the EPHPP tool, which was created and validated for the quality assessment of studies across the field of public health. Third, we did not include studies, which focused on specific populations or indications in order to derive findings for the general population. It is possible, but unlikely, to have missed unexpected benefits of medication charts. Finally, matrix with codes of different themes give a suitable and quick overview on the topic and provide arguments when discussing the necessity of medication charts.

This review has also some limitations. First, papers written in other languages than English or German were not searched, which may result in publication bias. Grey literature search was focused on German sources because at the time of our research, there was a political debate in Germany about the value of the recently introduced nationwide medication chart, leading to a hype media coverage. However, as the USA and Germany were among the first countries to investigate medication charts and to publish their research, we suppose that the most relevant studies were retrieved. Second, we focused on printed medication charts. There are plenty of opportunities to use electronic charts on websites (eg, 'My Medicine Record'[71]) or as apps for mobile devices (eg, 'MyTherapy'[72]). Electronic medication charts are likely to be increasingly implemented over the next years. Nevertheless, we postulate that the benefits observed in our study, as well as the terms and conditions surrounding the use of a medication chart, will remain independent of the format. Finally, the included studies used various methods, which partially were not validated or evaluated. Given the fact that there is no gold standard for many of the discussed topics, these diverse methods represent the current situation in this research field.

CONCLUSIONS

The reviewed studies suggested some benefits linked to the use of a medication chart for patients and healthcare providers. In some studies, patients demonstrated an increased knowledge about their medical treatment, which may be linked to a higher medication adherence. For healthcare providers, a medication chart may enable an improved interdisciplinary cooperation and represents

a useful counselling tool with patients. Considering the overall weak study quality and the use of various data collection methods on one hand, and the more robust qualitative study results, on the other hand, we claim that evidence of our finding is moderate. Unfortunately, high-quality prospective studies on this topic are rare. Importantly, it is unknown whether the observed benefits will lead to an improvement in the clinical outcomes. For healthcare providers, several questions are still not answered satisfactorily such as who is responsible for the accuracy of the medication chart or who is in charge in case of discrepancies.

For patients and healthcare providers the benefit of using medication charts is beyond doubt. With our review, we were able to contribute moderate evidence to support this common sense. In order to provide results with enhanced evidence, we depend on further research and future studies with good quality.

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Online supplementary

Online supplementary A: Literature databank search string

("medication plan*" [MeSH]) OR ("medication list*" [MeSH]) OR ("medication schedule*" [MeSH]) OR ("medication chart*" [MeSH]) OR ("Medikationsplan" [MeSH]) OR ("Medikamentenplan" [MeSH]) OR ("Medikationsliste*" [MeSH]) OR ("Medikamentenliste*" [MeSH]) OR ("Medikamentenpläne" [MeSH]) OR ("Medikationspläne" [MeSH]) OR ("medication plan*" [Title/Abstract]) OR ("medication list*" [Title/Abstract]) OR ("medication schedule*" [Title/Abstract]) OR ("medication chart*" [Title/Abstract]) OR ("Medikationsplan" [Title/Abstract]) OR ("Medikamentenplan" [Title/Abstract]) OR ("Medikationsliste*" [Title/Abstract]) OR ("Medikamentenliste*" [Title/Abstract]) OR ("Medikamentenpläne" [Title/Abstract]) OR ("Medikationspläne" [Title/Abstract])

Online supplementary B: PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2, 3, 5
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4, 5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5, 6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Online supplement A
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6, 7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	NA
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6, 7
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7, 8, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7, 8, Online supplement C
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7, 8, Online supplement C
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8-11
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	11, 12

Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14, 15
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	15, 16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	16

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Online supplementary C: Characteristics of 30 included studies (all contents were expressed in the original language)

No	First author, year of publication	Design	Population	Country	Aim	Method	Benefit	Quality
1	Botermann, 2016 [1]	CSS	N = 90 patients, Ø age: 69 y, ♀: 47%, drugs per patient: 8±3	GER	Comprehension of MC, transfer information into practice	Structured interviews and practical part: fictional MC (6 drugs) had to fill a pillbox for 48h, interview about attitude towards MC; quantify comprehension with an evaluation tool (ET-MP) ranging from 0 - 100%, <90%: patient didn't comprehend MC, >90%: patient comprehended MC;	86% rated MC as clearly arranged, 82% rated MC as helpful, 78% would take their MC to every doctor's appointment or pharmacy visit; 43% were able to transfer the written information into practice; medication list has been identified as a patient safety indicator, MC can only improve medication safety if it is complete and up to date, MC only is not enough to improve safety;	WEAK
2	Manning, 2007 [2]	RCT	N = 138 patients, Ø age: 68 y, ♀: 54.7%, drugs per patient: 9.4	USA	comparison of two MCs regarding: satisfaction, knowledge and medication errors	Discharge: each patient randomly received either a MDW or 3D-MC, patients with 3D-MC could affix a tablet/capsule onto the plan, structured telephone interview after 7-14 d (research assistant blinded) about satisfaction with MC, knowledge of medication (indication, dosing frequency, special comments or cautions) and self-reported safety ("Did the MC assist you in preventing medication errors?");	no difference in patient satisfaction or self-reported medication errors; 3D-MC was associated with greater understanding of prescribed medications ($p<0.0282$); Over 80% of all patients indicated that MC helped them ''avoid making mistakes with medications''; 3D-MC offers an advantage in patient medication knowledge;	STRONG
3	Eickhoff, 2019 [3]	Q/WS	N = 11 Arzt-Apotheker-teams	GER	Umsetzung/ Machbarkeit der Software zur Produktion von BMP, Akzeptanz von Ärzten und Apothekern	Erstellung, Austausch und Aktualisierung von MCs im Alltag, pharmazeutische und ärztliche Medikationsanalyse: AMTS Prüfung der Medikation; Fragebögen: Motivation der Teilnahme, Zufriedenheit mit technischer Umsetzung, den Prozessen im MM, dem Projektnutzen und der Verwendung des MC durch Patienten (N=196); Workshop mit Ärzten und Apothekern;	6/10 Ärzte, 5/8 Apotheker waren insgesamt mit den Prozessen zufrieden; Einbettung von Bewertungstool (z.B. PRISCUS-Liste) in Software gewünscht; MC ist verständlich für Patienten (8/10 Ärzte, 7/8 Apotheker), 80% bewerten die Kommunikation zwischen Arzt-Apotheker als positiv, Ärzte erfahren mehr über Medikation anderer (Fach-)Ärzte (7/10), Apotheker erfahren mehr über Gesundheitszustand der Patienten (7/8); Verbesserung des fachlichen Austauschs und beruflichen Zusammenarbeit, BMP wird als Instrument für Erhöhung der AMTS eingestuft, für die Mehrheit der Teilnehmer lohnt sich der höhere Zeitaufwand im Hinblick auf AMTS Verbesserung;	WEAK

4	Strauss, 2018 [4]	CSS	N = 375 Passanten, Ø Alter 57 J, ♀ 63.2%, ≥1 AM pro Teilnehmer: 61.9%	GER	Welchen Nutzen sehen Bürger in einem MC; aus welchen Gründen würden sie einen MC nutzen bzw. nicht nutzen;	qualitative Feldbefragung mittels teil-standardisierten Interviewleitfaden mit offenen Fragen, MC („MeinPlan“) als Anschauung;	Orientierungshilfe (Dosierung/ Einnahmezeit; 25.7%), Gedächtnisstütze (Verwechslung vermeiden; 9.6%), Dokumentationsmittel (3.9%), Informationsquelle (Überblick über WW, UAW 3.9%), Reflexion über Gesundheitszustand (2.9%); 37.3% Kommunikation mit GDL, Schaffung von Transparenz; Hilfe für Angehörige/Dritte bei komplexer Therapie; Möglichkeit zur Verbesserung der AMTS; Mehrheit sehen hohen Nutzen im Führen eines MC: ärztliche Vorgaben können vom Patienten selbst verfolgt werden, Förderung der AMTS/Adhärenz (richtige Einnahme trotz mehrerer Medikamente, WW vermeiden, Doppelverordnung vermeiden), nur Aushändigen eines MCs genügt nicht zur Förderung der AMTS, Wirtschaftlichkeit (Zeitersparnis bei Anamnese, überflüssige AM identifizieren);	WEAK
5	Leonhard, 2008 [5]	CSS	N = 596 patients, Ø age 71.3 y, ♀ 62.75%	USA	improve the accuracy of MCs;	patients got a personal MC and medication bag for transporting medicines at hospital discharge, outcome measure: number of accurate MCs before and after intervention, patients received training on medication safety and importance of communication with their providers, post-intervention survey with patients; "accurate MC" was defined as the conformity between the clinics‘ medication chart and the patients‘ MC or bag of medicines;	69% felt the personal MC made it easier to talk with their provider about their medications; comments from provider: MC helps having a more accurate MC on file, MC support communication, partnership tool for patient-provider communication, preferred self-management tool by patients and providers, measured awareness of patients of the importance of sharing medicines with all healthcare providers, 55% of the MCs in the interventions clinics were accurate (63% in control clinics) at baseline, after intervention: 72% (+17%) vs. 56% (p=0.034);	WEAK
6	Rose, 2017 [6]	CSS	N = 142 patients, Ø age 76.7 y, ♀ 53.5%, drugs per patient: 10.5	GER	estimate and rank discrepancies between prescription and actually taken medicine, impact on medication safety;	standardized assessment questionnaire at patients home about drug regimen (name, strength, prescriber, dosage, timing, indication, handling), adverse drug events, falls, pain, vertigo, social support; comparison of medication with physicians documentation, relevance classification of discrepancies: risk for hospitalization, falls and potential DDI: "low risk" or "high risk";	discrepancies affected 94.4% of patients, 2.8 drugs per patients were not documented, 13.7% patients used an undocumented drug with risk for falls, 76.1% patients used an undocumented drug with risk for DDI, 65.8% of the undocumented drugs caused at least 1 DRP;	WEAK

7	Waltering, 2015 [7]	CSS	N = 500 patients, Ø age 72.9 y, ♀ 54.7%, drugs per patient: 8.6	GER	define factors that influence accuracy of MCs, detect discrepancies from planned and actually taken medication;	Medication review (type 2a): patient interview, data from pharmacy records and brown bag analysis were compared to current MC;	6.5% of MCs showed no discrepancies; mean of 5.4 discrepancies per plan, one Rx drug is missing on every second MC;	WEAK
8	Bruehwiler, 2016 [8]	CSS	N = 45 patients, Ø age 67.6 y, ♀ 40.0%	GER	do patients understand MCs, ask for patients' needs	patients were given 4 fictive MCs with 7 drug regimen, proof of comprehension with open questions, asking for need of additional content of the MC, design an individual MC in an empty table;	73% correctly interpreted the abbreviation «Mo» as «Morgen», 24% incorrectly as Monday, «Na» (Nacht) was recognized as bedtime by 56%; 11% understood: afternoon (Nachmittag); 42% correctly interpreted the maximum daily dose regarding the instruction «max. 2 tablets max. 4×/24 h», «ML» was understood by 24%; 91% preferred brand names in the first column, eMediplan is favorite for experts and patients for overview;	WEAK
9	Vasileff, 2009 [9]	CSS	N = 74 patients, Ø age 76.5 y, ♀ 52.2%, drugs per patient: 7.9	AUS	determine frequency and clinical significance of medication errors	compilation of medication history before (intervention group) and after (control group) the patients being seen by a doctor using MedMAP (tool for communication of medications-related issues) comparison of patients' history with prescribed medicines;	accuracy increased when the pharmacy researcher prepared MC; increased accuracy significantly reduces the frequency of unintentional discrepancy from 78.6% to 3.3%, average number of discrepancies from 2.51 to 0.03 ($p<0.05$) per patient; most frequent unintentional medication error was medication omission: 75.6% control group vs. 3.4% intervention group, 2.35 doses per patient missing in control group vs. 0.24 ($p<0.05$); 52% of discrepancies with potential significant impact on patients' health outcome;	WEAK

10	Raynor, 1993 [10]	RCT	N = 197 patients, Ø age 69 y, ♀ 44.2%, drugs per patient: 3.65	UK	investigate whether a MC improves compliance or knowledge of drug regimen	At discharge: one half got routine nurse counselling, the other half pharmacist counselling, 50% of each group got an individualized MC, interviews after 10 days at home, compliance was measured by pill count, compliance score: number of tablets taken divided by the correct number of tablets x 100%;	knowledge of drug regimen (how many times, how many doses each time, actual time): 83% (with MC) vs. 47% (w/o MC); compliance score: 93% with MC vs. 86% w/o MC (p<0.001); MC had a significant effect on compliance; significantly increased number of patients who correctly answered questions about their drug regimen (p<0.001);	MODERATE
11	ABDA, 2014 [11]	Report	-	GER	Überblick über Konzepte zur MA und MM als Tätigkeit in Apotheken	Verdeutlichung Unterschied MA und MM, verschiedene Typen der MA, Abgrenzung der MA/MM als Dienstleistung von Beratung/Information bei AM-Abgabe, Darstellung des aktuellen Stands in GER, Voraussetzungen für Implementierung, Bedeutung für Patienten und interprofessionelle Zusammenarbeit;	aktueller, vollständiger MC von zentraler Bedeutung für Medikationsprozess und AMTS, MCs können Missverständnisse bzgl. der Anwendung vermeiden, Adhärenz verbessern, für Behandlungserfolg und zur Reduktion von ABP sollte Patient gut über Therapie informiert sein und aktuellen MC besitzen; am Übergang ambulant zu stationär kann aktueller MC entscheidenden Beitrag zur AMTS leisten, erleichtert Anamnese;	n.a.
12	Freyer, 2016 [12]	Kohorten-studie	N = 179 Patienten, Ø Alter 77 J, ♀ 60.34%, Arzneimittel pro Patient: 8.5	GER	Untersuchung des Wissens-stands über AM von Patienten bei KH-Entlassung, Einfluss-faktoren identifizieren	strukturiertes Interview am Tag vor KH-Entlassung, Fragen zu Entlass Medikation (WS/AM-Name, Indikation, Darreichungs-form, Wirkstärke, Dosierschema), Vergleich mit stationärer Patientenakte/Akte beim Hausarzt; Definitionen: Wissenstand = Anteil zutreffend benannter Medikamente pro Patient;	48% benannten AM-/WS-Name richtig; Einflussfaktoren für Wissensdefizite: kein MC, Patienten mit MC konnten mehr Entlassungsmedikamente zutreffend benennen; Verwendung eines MCs führt zur Erhöhung des Wissensstands um 45.42% (p<0.001), MC ist geeignete Unterstützung zur strukturierten Beratung über Entlass Medikation, Aushändigung eines (vollständigen) MC ist wichtige qualitätssichernde Massnahme zur Sicherstellung der Patientensicherheit an Behandlungs-übergängen; signifikanter Zusammenhang zwischen Wissensstand der Patienten und Einflussfaktor „Nutzung eines MCs“, >75% bekamen bei Entlassung mind. ein neues AM verschrieben;	WEAK

13	Kannampalli l, 2013 [13]	Cohort study	N = 144 patients, Ø age 71 y, ♀ 64%	USA	comparison between standard used MedCard and new developed Medtable,	patients were paired randomly as the role of a patient or provider, each pair got one out of three MCs: MedTable, eMedTable or MedCard, solving of a simple and a complex problem: 4 drugs (name, purpose, size of dose, frequency, special instructions) and the patients' daily routine (bedtime, work schedule), compare with optimal solution; measures: medication problem-solving performance, collaborative process, tool usability, subjective workload;	structured tools are easier to use, structured tools create more accurate and optimal schedules ($p<0.05$), supports active role of patient;	WEAK
14	Elliott, 2012 [14]	Cohort study	N = 428 patients, Ø age 84 y, ♀ 60.85%, drugs per patient: 10.5	AUS	Test the impact of MC on medication errors and use of locum medical services after discharge	Discharge from hospital to RCF, got a MC and medication for 7 d, interview with RCF member 24 h after discharge, questionnaire: time of arrival, updating of MC, missed/delayed doses, questionnaire for GPs: satisfaction with MC; primary endpoints: proportion of missed doses and updated MCs <24 h after discharge;	significant reduction of missed/delayed doses: 18.3% pre vs. 2.7% post ($p<0.001$); MC update by GPs reduced from 32.7% pre vs. 11.9% post ($p<0.001$), RCF staff reported IRCMAC improved continuity of medication admission, 88.6% of primary care doctors reported reduced urgency to attend the RCF after patients arrival;	MODERATE
15	Coombes, 2009 [15]	Cohort study	N = 1481 patients	AUS	implement MC in hospitals, investigate impact on prescribing errors, ADR and safety	MC includes previous ADR and warfarin management (INR values), investigation of prescribing errors and ADR before and after implementing a MC, checking prescriptions for discrepancies;	proportion of prescribing errors per order per patient decreased from 20% to 15.8% ($p=0.03$); rate of prescribing of medication to which the patient had a previous ADR decreased by 59%, from 11.3% to 4.6% ($p=0.021$); INR >5 (increased risk of bleeding) decreased from 1.9% to 1.45% ($p=0.004$), MC reduced significantly the frequency of prescribing errors and reduced exposure to drugs causing previous ADR, decreased the potential risk of warfarin management;	MODERAT

16	McManus, 2018 [16]	RCT	N = 76 patients, Ø age 49 y, ♀ 36.8%	IRE	impact of a MC on the knowledge and consolidation of drug regimen	patient received a fictional MC and 5 medication regimen with labelling, were asked to prepare a 24 h pillbox, control group w/o MC, measurement of knowledge by asking three standard questions (how many tablets at any one time? How many tablets in a day? Are there any precautions you would take while taking this medicine?)	mean knowledge score 9.28 compared to 8.81 (control group), not statistical significant (p=0.135); knowledge on medication regimen is slightly higher with MC, larger impact and improvement on prescription understanding in patients with low understanding of medicines;	STRONG
17	Send, 2014 [17]	Cohort study	N = 90 patients, Ø age 59.3 y, ♀ 54%	GER	effect of an EMP on patients' knowledge, transfer of information at conversation with physician at discharge	observing patient-physician conversations at hospital discharge before and after integration of an EMP, standardized check list (duration, details about drugs, method of drug information transfer), afterwards 3 questions about medication (e.g. at what time of the day are you supposed to take your tablet? how to take medication regarding food intake?)	time spent on individual drug therapies increased significantly by 61.7% (from 2.13 min to 3.18 min, p=0.02) by using an EMP, time spending on providing information about indication increased (+28%); Three times more patients answered all questions correctly with EMP (w/o 17.9%, with 60%, p<0.01); More drug information were given about previously prescribed drugs (w/o 64.5%, with 80.4%), and newly prescribed drugs (92.2% vs. 98%); the amount of information on drugs/drug application (indication, treatment duration) increased significantly (w/o 75.1%, with 84.6%, p=0.02), more answers were correct with EMP, especially questions on indication and food intake;	WEAK
18	Jäger, 2015 [18]	Cohort study	N = 344 patients, Ø age 72.1 y, ♀ 57.6%	GER	explore if beliefs about medicine are associated with use of MC and memory of medication counselling	questionnaire during practice visit, German version of BMQ, additional items on presence and use of MC (showing it to GP or pharmacist), comprehension of MC, process of updating MC, memory of having received a medication counselling or brown bag review;	50.6% consider their MC an important reminder; 42.4% used it for administering their medication; patients who found MC comprehensible had less concerns about medication (p<0.01); 30.2% are showing their MC during doctors' appointments; 4.1% when buying a drug in the pharmacy; regular receipt of an updated MC was associated with higher perceived necessity of the medication (p<0.01);	WEAK

19	Wilke, 2018 [19]	Kohorten-studie	N = 279 AOK Plus Versicherte, Ø Alter 72 J, ♀ 50%	GER	Vergleich der AM-Kontinuität mit und ohne MC bei KH-Aufnahme und Entlassung	Erfasste Daten bei stationäre Aufnahme: Diagnosen, Medikation, vorhandener MC und Autor des MCs; vorhandene GKV Daten: Alter, Geschlecht, AM 6 Monate vor und nach Hospitalisierung; Abgleich Medikation bei Aufnahme mit Entlassmedikation, Übereinstimmung wenn ATC-Code gleich blieb (gleicher WS oder WS-Kombination);	62% der Patienten hatten MC bei KH-Aufnahme; Weiterverordnung von AM bei KH-Aufnahme: 53% mit MC vs. 40% ohne MC (p<0.001); kein Unterschied bei Entlassung, das Verwenden eines MC kann die Anzahl der AM-Umstellungen reduzieren, AM-Kontinuität steigt (ambulant-stationär);	WEAK
20	Chae, 2009 [20]	Longi-tudinal study	N = 104 patients, Ø age 60.4 y, ♀ 66.6%	USA	determine the acceptance of MC and its influence on patients' knowledge of their medical care	MC (foldable, wallet-sized) was distributed to patients, PMS to asses patients responsibility, physicians responsibility and patients knowledge of their medical care (drug name, dosage, indication); phone call 4-11 M later to readminister the PMS, comparison of the responses;	patients using MC showed increased scores in perceived patient knowledge about their medication (p=0.049) and patient responsibility (p=0.031), with no change in their perceptions of physician responsibility; majority of patients using the card indicated that the card was easy to use and carry; MC is an information source across healthcare setting;	WEAK
21	Kuske, 2012 [21]	SR	N = 4 Delphi-Experten	GER	Identifizierung von AMTS-PS-Indikatoren	systematischer Review zur Identifizierung von AMTS-Indikatoren; Bestimmung PSI als Untergruppe und Priorisierung; Prüfung auf Übertragbarkeit auf AM-Versorgung; Entwicklung von Empfehlungen;	Ergebnis: 14 AMTS-PSI; Nummer 3 = Medikationsliste; Nummer 12 = Übergabe der Versorgung – Patienten, welche die Zielsetzung ihrer Medikamente verstehen;	WEAK
22	Kiel, 2018 [22]	CSS	N = 637 Patienten, Ø Alter: 67 J, ♀ 57% (Ein-schluss-kriterium 1 - 10 AM)	GER	Ermittlung der Auskunfts-fähigkeit von Patienten über Medikation	Interview (persönlich, telefonisch und postalisch) in Arztpraxen mit Patienten über ihre Medikation (Name, Dosis, Einnahmefrequenz, Indikation), Vergleich mit Praxisdokumentation;	Übereinstimmung von 54% bezüglich Anzahl AM, Besitz eines MCs zeigte keinen Einfluss auf AF; die Benutzung eines MCs verbessert die AF, ausgeprägter Effekt bei Patienten >5 AM; mit zunehmender Anzahl von AM nimmt die AF ab; 75% kannten den Namen ihrer Medikamente, MCs verbessern die Fähigkeit, korrekte Angaben zu Namen, Einnahmefrequenzen und Dosierungen zu machen;	WEAK

23	Kenning, 2015 [23]	QE	N = 15 patients, Ø age 74.5 y, ♀ 53%, drugs per patients 8.7, N = 10 pharmacists; N = 10 GPs	UK	explore the need for and acceptance of UMS	semi-structured interviews with patients at home: explore knowledge of medication (indication, dosage), adherence (how they took medication), managing multiple medications, how they get medication information; showing them UMS (useful content?), interview with pharmacists and GPs (patients understanding, adherence, barriers, views on UMS);	It (MC) would help them (patients) to prevent errors; most GPs/pharmacists thought a UMS could be feasible, acceptable and beneficial to patients; acting as reminder chart; UMS is a useful tool for communication between healthcare settings;	WEAK
24	Blake, 2010 [24]	QE	N = 23 focus group, Ø age: 52 y, ♀ 60.8%, N = 7 pharmacists Ø age: 43 y, ♀ 75%	USA	evaluate a health literacy intervention to improve medication adherence with an illustrated MC "PictureRx" card	focus group with pharmacy patients: using, understanding and satisfaction with MC, reminder calls to refill, quality of pharmacists' counselling; 1 and 6 month after intervention interviews with pharmacists: interaction with patients (especially those with limited literacy) reminder calls, understanding of and satisfaction with MC, communication training;	most pharmacists felt the MC was easy to use and provided an important counselling tool for their patients; clear health communication tool;	WEAK
25	Send, 2017 [25]	RCT	N = 115 patients, Ø age 70.3 y, ♀ 50.4% ,≥5 drugs per patient	GER	effect of MC on patients‘ knowledge after 2 month	control group: simple MC, intervention group: MC with additional information: indication, explicit drug administration recommendations, pictograms for food intake information), knowledge proof before handing out MC (baseline assessment) and after 2 month (follow-up assessment) by using 3 questions which where personalized regarding their current medication (Do you know the reason why you have to take ibuprofen?);	patients’ drug knowledge (especially on indication and food intake) showed an absolute increase of 23.2% in the intervention group (baseline: 40.6% correct answers, follow-up: 63.8%, $p<0.01$), knowledge of control group was unchanged;	MODERAT

26	Dormann, 2017 [26]	Kohor-ten-studie	N = 863 Patienten ambulant	GER	Wirksamkeits-analyse, Evaluation der AMTS	Drei Phasen: Einstellungsakzeptanz, Handlungsakzeptanz, Evaluations-akzeptanz; Bewertung MC bezüglich AMTS-Eignung, Vergleich Medikation Praxisdaten mit aktuellem MC und Brown Bag Analyse, Fragebogen Patient: Einstellung zu Medikation, selbstberichtete Adhärenz Morisky-Scale (6-item, 0 = adhärent);	35.6% (Visit2) bzw. 27.1% (Visit3) der Patienten waren durch den Einsatz des BMP besser über die Einnahme (Zeitpunkt, Grund) ihrer AM informiert; kein relevanter Unterschied in selbstberichteter Adhärenz; 58.3% der Ärzte führten ein zusätzliches Beratungsgespräch bei Erstellung des MCs, 32.4% der Ärzte/Apotheker konnte bei jedem 5. Patienten mittels BMP Kontraindikationen, UAWs oder Medikationsfehler identifizieren;	WEAK
27	Thürmann, 2017 [27]	Kohor-ten-studie	N = 161 ambulante Patienten, Ø Alter 69 J, ♀ 59,0%	GER	Erprobung des BMP hinsichtlich Akzeptanz & Praktikabilität sowie Untersuchung des Einflusses auf die Adhärenz	Implementierung webbasierte Software in Arztpraxen, KH und Apotheken; inkl. Mitarbeiter-schulung, Patienten erhielten bei AM-Anamnese BMP (vom Arzt), Beobachtung über 12 M, Befragung der Patienten und GDL nach 0, 6, 12 M; Akzeptanz, Praktikabilität, Zufriedenheit (SIMS) mit BMP, selbst-berichtete Adhärenz (MARS), Klassifikation von Medikations-problemen, AM-Änderungen, Wissen über Dosierung, Einnahme-hinweise, Einnahmegrund;	84.1% fühlten sich nach 12 M sicherer im Umgang mit ihren AM; Zunahme des Wissens über AM: Einnahmegrund (78.5%, Steigerung um 10%) Einnahmehinweise (76.6%, Steigerung um 9.7%); selbstberichtete Adhärenz blieb unverändert; Medikationsprobleme: Doppelverordnungen: keine Änderung, Einnahmefehler (v.a. Einnahmezeitpunkt): Abnahme (N = 160 vs. 125), AM-Interaktionen: Zunahme (N = 2.5 vs. 3.3); Patienten konnten mithilfe des MC ihre Medikamente im Alltag schneller stellen (64.5%, Steigerung um 10.5%);	MODER AT
28	Botermann, 2017 [28]	Q/W	N = 196 ambulante Patienten Ø Alter 74.4J ♀ 61.3%	GER	Umsetzung des BMPs in die Praxis, technische Umsetzung nach ARMIN	1. Technische Umsetzung: Bildung von Arzt-Apotheker-Teams, Test der Software (Probepatienten) 2. Praktische Umsetzung: Schulung der Mitarbeiter, Routinebetrieb mit Patienten 3. Akzeptanz des BMP: strukturierte Interviews mit Ärzten, Apothekern und Patienten (Wissenstand: Dosierung, Indikation);	klinischer Nutzen: Angemessenheit der Therapie und Umsetzung durch Patienten, humanistischer Nutzen: Lebensqualität der Patienten, ökonomischer Nutzen: positive Auswirkung auf Kosten; 2/3 der Patienten gaben an, dass sich ihr Wissen (Dosierung 64.1%, Indikation 71.8%) verbessert hat, 68.9% fühlten sich sicherer im Umgang mit ihren AM, für 83.5% war grösster Nutzen besserer Informationsaustausch mit GDL über AM;	WEAK

29	Dormann, 2018 [29]	Report	siehe Nr. 26-28	GER	Vorstellung 3er Modell-projekte, Ableitung von Empfehlunge n	Vorstellung der drei Modellprojekte aus Massnahmenkatalog 2013-2015 zur AMTS-Verbesserung mittels BMP: Metropol-Mediplan 2016, Erfurt und PRIMA; Ableitung von Empfehlungen basierend auf den gesammelten Resultaten;	Anstieg der Patientenzufriedenheit und der Medikations-kompetenz, interprofessionelle Zusammenarbeit, bedeutender Effekt auf AMTS;	n.a.
30	Müller, 2018 [30]	Inter-views	N = 546 Ärzte, N= 969 Apotheken, N = 3200 Patienten	GER	Implementier ung des BMP	Zukunftskonzept AM-Versorgung: Wirkstoffverordnung (statt Verordnung von Präparaten), Medikationskatalog (Unter-stützung von Ärzten bei AM-Auswahl) und MM: Brown Bag Analyse, Beratungs-gespräch (Kenntnisse, Adhärenz, Zufriedenheit) und AMTS-Prüfung (durch Apotheker und Arzt) gemeinschaftliche Erstellung und Pflege eines MCs, wiederholte Prüfung der Gesamt-medikation, elektronischer Datenaustausch	Umsetzung der Therapie durch die Patienten, die Angemessenheit der AM-Therapie, das Wissen der Patienten zur korrekten Dosierung und Anwendung ihrer AM und Gründen der Einnahme;	WEAK

Abbreviations: **3D:** Durable Display at Discharge; **ABDA:** Federal Union of German Associations of Pharmacists (Bundesvereinigung Deutscher Apothekerverbände); **ABP:** adverse drug event (Arzneimittelbezogene Probleme); **ADR:** adverse drug reaction; **AF:** provide information (Auskunftsfähigkeit); **AM:** drug (Arzneimittel); **AMTS:** medication safety (Arzneimitteltherapiesicherheit); **AMTS-PSI:** factors for patient and medication safety (Patientensicherheitsindikatoren zur Arzneimitteltherapiesicherheit); **AOK:** health insurance company (Allgemeine Ortskrankenkasse); **ARMIN:** drug initiative Saxony-Thuringia (Arzneimittelinitiative Sachsen-Thüringen); **ATC Code:** Anatomical Therapeutic Chemical Classification; **AUS:** Australia; **BMP:** standardized medication chart in Germany (bundeseinheitlicher Medikationsplan); **BMQ**: Beliefs about Medicines Questionnaire; **CSS:** cross-sectional study; **d:** days; **DDI:** drug-drug-interaction; **DRP:** drug related problems; **EMP:** enhanced medication plan; **GDL:** health care provider (Gesundheitsdienstleister); **GER:** Germany; **GKV**: statutory health insurance (gesetzliche Krankenversicherung); **GP:** general practitioner; **h:** hour; **INR:** International normalised ratio; **IRCMAC:** interim residential care medication administration chart; **IRE:** Ireland; **J:** years (Jahre); **KH:** hospital (Krankenhaus); **M:** months; **MA:** medication review (Medikationsanalyse); **MARS:** Medication Adherence Report Scale; **MC:** medication chart; **MDW:** Medication Discharge Worksheet; **ML:** measuring spoon (Messlöffel); **MM:** medication management; **N:** number (Anzahl); **n.a.:** not applicable (nicht zutreffend); **PMS:** Patient Medication Scale; **Q/W:** questionnaire/workshop; **QE:** qualitative evaluation; **RCF:** residential care facility; **Rx:** prescription drug; **SIMS:** Satisfaction with Information about Medicines Scale; **SR:** systematic review; **UAW:** adverse drug reaction (unerwünschte Arzneimittelwirkungen); **UK:** United Kingdom; **UMS:** Universal Medication Schedule; **w/o:** without; **WS:** active ingredient (Wirkstoff); **WW**: interaction (Wechselwirkung); **y:** years

Online supplementary D: Matrix with codes of the theme «Patient» (51 codes in original English or translated from German)

Category / Population	Knowledge	Safety	Purpose	Communication	Empowerment
Physicians/ pharmacists	▪ indication [30] ▪ dosage [30] ▪ drug application [30]	▪ patient safety indicator used for medication safety [21] ▪ allow identification of contraindications, adverse drug reactions and medication errors [26]	▪ reminder chart [23] ▪ transfer written information into practice [30]	▪ communication and counselling tool [5, 24, 26]	
Patients ambulant/ nursing home	▪ indication [20, 22, 25-28] ▪ dosage [16, 20, 22, 28] ▪ food intake [25] ▪ dosing frequency [16, 22] ▪ dosing time [26] ▪ drug name [20, 22] ▪ precautions [16] ▪ special taking advice [27]	▪ avoiding errors [30] ▪ safer handling of medication [28] ▪ less delayed or missed doses [14, 27]	▪ information source [20] ▪ documentation aid [6, 7] ▪ reminder [18] ▪ transfer written information into practice [1, 28] ▪ regarding speed [27] ▪ creating more accurate and optimal schedules [13]	▪ exchange of information with health care provider [28]	▪ supports active role of the patient [13] ▪ patient responsibility [20] ▪ less concerns about medication [18] ▪ higher perceived necessity of medication [18] ▪ awareness of sharing all information with healthcare providers [5]
Patients hospitalized /discharged	▪ indication [2, 17] ▪ dosage [10] ▪ food intake [17] ▪ dosing frequency [2, 10] ▪ dosing time [10] ▪ drug name [12] ▪ special instructions, cautions or comments [2]	▪ avoiding mistakes [2] ▪ compliance [10]	▪ documentation aid [9]	▪ easier to talk with provider about medication [5] ▪ counselling tool [12, 17]	
Citizens		▪ avoiding interactions [4] ▪ increased adherence under polypharmacy [4]	▪ reminder aid [4] ▪ source of information [4] ▪ documentation aid [4] ▪ orientation guide [4] ▪ reflection tool [4]	▪ communication tool [4]	

Online supplementary E: Matrix with codes of the theme «Process» (13 codes in original English or translated from German)

Category / Population	Interdisciplinary cooperation	Resources	Patient files	Prescription
Physicians/ pharmacists/ hospital	▪ physicians learn about prescriptions of other physicians [3] ▪ pharmacists learn about patients' diagnoses [3] ▪ communication aid between different services [23, 29]	▪ time saving [3] ▪ appropriate medical therapy [28, 30] ▪ continuity of medication at discharge decreases urgency for GP to attend the nursing home [14]	▪ medication chart on file is more accurate [5]	▪ consider previous adverse drug reactions [15] ▪ avoiding medication omission and incorrect doses [9] ▪ continuity of medication [19]
Citizens		▪ identify unnecessary medication [4] ▪ time saving [4]		▪ avoiding drug duplication [4]

GP: general practitioner

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