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# Using the German National Medication Plan for Clinical Studies in Practice-Based Research Networks

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**Abstract.** The German National Medication Plan (GNMP) can be a valuable and interoperable data source for clinical studies, due to its digital specification and mandatory provisioning for chronically ill patients. Digital transfer of a patients current GNMP from the Patient Data Management System (PDMS) into electronic case report forms would avoid error prone manual data capturing. It is also essential for studies in practice-based research networks (PBRN), where data capturing must have as little impact as possible on everyday practice. The following issues are currently preventing seamless digital integration: There is no standardized interoperable export of the GNMP from PDMS. In the current form, pharmaceutical catalogs are needed to decode the contained pharmaceutical registration numbers. As accessibility to the pharmaceutical catalogs is restricted, there is no generic access to the actual information needed for study data evaluation. In order to conduct studies, feasible workarounds for these issues had to be implemented in the standard operating procedures, tools and participating GP practices. To overcome the GNMP's current lack of digital interoperability, the proposed solution combines semi-automated data export from PDMS at the GP practice and manual database search at the study center with a semi-automated processing pipeline to balance workload between GP practices, study management and evaluation.

**Keywords.** German Nation Medication Plan, Standardization, Medical Data Science, Health Informatics Standards, Health Information Interoperability

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## 1. Introduction

Practice-based research networks (PBRN) have become an integral part of primary care to gain medical knowledge by clinical studies [1]. To support general practitioners (GP) to participate in prospective clinical studies, a digital infrastructure was developed and implemented by the FoPraNet-BW project in Germany for the first time [2]. The infrastructure provides digital tools for the GP practices to manage locally recruited patients and capture the study data, while the central study management has tools to supervise the progress in all participating GP practices. Two of the observational studies with 50 GP practices and currently over 800 participants depend on information about current medication. A direct import of medication data from the Patient Data Management System (PDMS) into the electronic case report forms (eCRF) would facilitate data capturing, avoid error prone manual transfer and should be possible since providing the German National Medication Plan (GNMP) is mandatory for PDMS-software in Germany [2]. Although the GNMP has been specified in the HL7-FHIR standard there is currently no generic electronic interface available in German PDMS to provide this resource. On the contrary, the GNMP has been established in a hybrid solution resulting in a printable PDF sheet containing a tabular human readable representation of the data and a Data Matrix 2D Barcode encoding its reduced XML representation (UKF, German: Ultrakurzformat) [3]. A feasible and sustainable technical approach is needed to transfer the data from the existing GNMP into the generic eCRF for standardized evaluation. To make data from the proprietary GNMP available for international clinical research, a retransfer to the international HL7-FHIR standard is needed. This requires a digital extraction of the UKF from the clinical routine into the research database. Since there are no standardized digital interfaces from PDMS to extract a GNMP a feasible solution is needed based on the standard available PDF sheet and 2D Data Matrix. To understand all requirements, the entire data capture pipeline for studies in the PBRN is considered and the approach is integrated as an operational solution.

## 2. Methods

### *2.1. Known Challenges*

In Germany, there is a wide range of more than 130 different types of PDMS available. The export function for the GNMP which is uniformly available in all these PDMS provides the printable PDF sheet, containing the UKF in the Data Matrix. The UKF consists of single letter XML element labels, basic patient and GP identification data (IDAT) and the dosing scheme along with pharmaceutical registration numbers (PRN) for each drug. It can be obtained via an appropriate scanner. These devices should be available in the GP practices since they are also used for laboratory order barcodes. The PRN are indexing a catalog of all authorized pharmaceuticals in Germany, containing details such as product names and active ingredients which is maintained by the Federal Institute for Drugs and medical devices (FIDMD). If a GNMP contains an PRN, all fields derived from it are not listed in the UKF. Reconstructing the complete GNMP needs queries in this catalogue, aggravated by the fact that there are publicly available and

[2] https://www.forschungspraxennetz-bw.de/

restricted parts needing a justified access. Only the relation between trade name of a drug and PRN can be found in publicly available databases. Without openly accessible pharmaceutical databases an automated parsing between tabular representation and 2D Barcode Data Matrix is not possible [3]. Additionally, GNMPs are often outdated and are in need to be updated prior to data collection to avoid incorrect data [2].

### *2.2. The FoPraNet-BW Infrastructure*

In the FoPraNet-BW project, GP practices are equipped with a study management software to conduct studies that streamlines case finding, recruitment, and subsequent processes on premise. Only after successful recruitment including consent of a participant, a pseudonym is provided by the central management server and a set of individual data collection links to the eCRFs on the central REDCap-Server is created, where collected study data is stored.

### *2.3. Developing the Pipeline*

In order to realize the provisioning of the GNMP for clinical studies, the first process to transfer the XML short format from the PDMS into an evaluable medication list must be developed. The UKF can be scanned as a character string into an appropriate eCRF field to get the data from the practice. After the data collection for the study is finished the second process is triggered during data evaluation to decode the XML string and link the FIDMD catalogue with the contained PRNs, resulting in the original medication list as presented in the printable GNMP. Integrating the GNMP as an entry into such an eCRF respects the generic data capturing approach and needs no further adaptions.

## 3. Results

### *3.1. Preparing the general practices for GNMP collection*

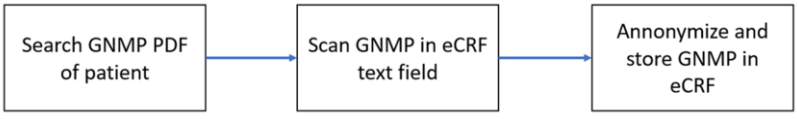


**Figure 1.** GNMP collection process.

Figure 1 illustrates the process of GNMP collection in GP practices. The patient ID in the PDMS is used to access and export the GNMP. Due to heterogeneous user concepts between different PDMS, there are various ways to generate the PDF containing the 2D Data Matrix. Practice staff are often unfamiliar with these different options. For this reason, practices have the possibility to exchange in a PBRN network forum or contact the IT-support. Before transferring the eCRF from the practice to the central REDCap server, the IDAT is deleted from the specific XML elements to ensure data protection by anonymization. The REDCap Java Script Injector Module is used to anonymize and validate the GNMP data and structure. However, during the voluntary collection of GNMP data during a first study (BEBOP PMR), 77.09% of GP practices did not provide GNMPs because many practices didn't have a scanner at that time. In addition, practices

were trained and financial assistance was extended to practices that lacked the necessary scanning equipment. Increasing the number of practices using the GNMP as replacement for manual entries by 39.84% for the last study (BEBOP HI). The practices were explicitly informed about updating the GNMPs of the study participants and correctly setting up the scanner to ensure the reliability of the GNMP data and structure. With these prerequisites, the practices can collect the GNMP.

### *3.2. BNMP processing after collection*

Figure 2 illustrates the process to reconstruct the medication list. Data is exported from the from the REDCap storage and all eCRF fields containing the GNMP XML string are extracted along with the participants study pseudonyms. A parser is used to decode the UKF to retrieve a partial medication list. Depending on the study protocol, the required but missing fields described in section 2.1 need to be restored. As stated above, there is no public database to restore all entries. Accordingly, a practical option is manual data enrichment from other sources by the data evaluation team. This has been considered a feasible approach to relive the GP practice staff from error prone manually transferring or entering medication.

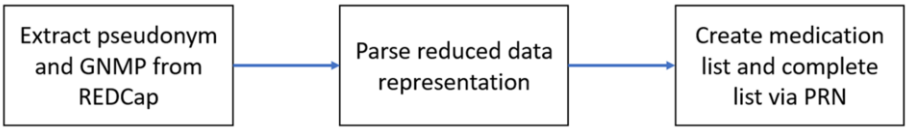


**Figure 2.** GNMP preparation process.

### *3.3. GNMP Usage*

We collected 399 GNMPs in three studies resulting in 2,980 medications. In some cases, outdated GNMPs did not deliver the PRN of the medication, if the PRN number was outdated too. Therefore, we advised our practices to update their GNMPs before data collection to achieve a good PRN coverage for the medications.

**Table 1.** Overview of the GNMPs extraction numbers

| Study | GNMPs | Practice % with GNMP | Medications | PRN Coverage | Dosage schedule |
|---|---|---|---|---|---|
| PMR | 35 | 22.91% | 241 | 94.58% | 99.83% |
| Depression | 128 | 34.00% | 599 | 95.65% | 90.37% |
| HI | 236 | 62.75% | 2,140 | 96.72% | 89.49% |

## 4. Discussion

We present a process using the GNMP as a data source, which reduces workload for GP practices in data collection but increases the work needed for data preparation. Through our active network of GP practices, we identified and rectified potential error sources such as the need for constantly updating the GNMPs. We developed data processing steps through requirement analyses and GNMP tests. Despite being standardized throughout Germany; the medication plan is not yet part of the daily routine in GP

practices. This leads to limited experience with the GNMP and a lack of reasons for the practice to have scanners. GP practices welcomed the possible workload reduction the newly developed process offers for data capturing. A major issue is the lack of a publicly available resources like databases to supplement GNMP data by using the given PRN.

## 5. Conclusions

Although the medication plan was initially designed as an HL7 FHIR resource, it was transferred to the proprietary UKF to be applicable in the German setting. In this paper, we describe a solution process that compensates this situation. The transfer of reconstructed medication lists back into HL7 FHIR enables research to process obtained GNMPs. This implies that the data can be returned to the research standard, and thus become accessible for global research like the European Health Data Space, which is currently discussed by initiatives such as the German Medical Informatics Initiative, the Swiss Initiative SPHN, and the Netherlands Health-RI.[3] In addition, part of the solution is the support of GP practices to ensure their readiness to scan and their understanding in the prerequisites for valid and complete provision of extractable medication data.

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*Study-Registry:* Study-registry: DRKS00032715 (BEBOP PMR), DRKS00033568 (BEBOP Depression), DRKS00033582 (BEBOP-HI, Heart Failure).

*Conflict of Interest:* The authors declare, that there is no conflict of interest.

*Contributions of the authors: C. Erhardt and P. Schmutz developed the necessary REDCap Modules, A. Polanc, C. Salm, G. Hübner and F. Peters-Klimm were part of the study planning and requirement analysis group and provided requirements for evaluation of the data. The required form of the extracted data was discussed with F. Peters-Klimm to provide sufficient evaluation data for the BEBEOP HI study. A. Krauss, S. Dörflinger and A. Becker were part of the developer team. P. Schmutz developed the scripts and wrote the manuscript. This project and the article is advised by C. Thies. All authors discussed the results and findings of this manuscript.*

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