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Potential of Electronic Medical Record Data for National Quality Measurement

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Abstract. National quality measurements with risk-adjusted provider comparison in health care nowadays usually require administrative or clinically measured data. However, both data sources have their limitations. Due to the digitalisation of institutions and the resulting switch to electronic medical records, the question arises as to whether these data can be made usable for risk-adjusted quality comparisons from both a content and a technical point of view. We found that most of the relevant information can be exported with little effort from the electronic medical records. In using this data source an even more sophisticated operationalization of the data of interest is needed.

Keywords. Computerized Medical Records Systems, Risk Adjustment, Quality of Health Care, Data Collection, Hospitals

1. Introduction

Demographic changes are increasing the demand for hospital services (1), while concurrently growing cost pressures and a lack of qualified staff threaten patient safety (2). To monitor patient safety and provide a data basis for comparing hospital and quality improvement, national quality measurements are carried out annually in Switzerland. Up to now, the data sources for national quality measurements have been predominantly based on "primary clinical data" (survey or direct observation) or (secondary) administrative data. However, both approaches are associated with limitations (3). Primary clinical data collection is associated with a possible non-response bias and significant personnel burden. Administrative data often lack detailed clinical information (e.g. variables necessary for risk adjustment) because they are usually generated for payment purposes and not for quality measurements. A promising alternative or supplementary data source for national quality measurements is (electronic) medical record data ([E]MRD, comprising in this study medical, nursing and other clinical records). MRD have a high level of detail in terms of clinical information, such as health status information and results of assessments, and are increasingly available electronically as hospitals become more and more digitised (3). A major challenge in the use of these data

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is the lack of standardisation and the different clinical information systems in which they are stored and, accordingly, the different interfaces. These are possible reasons why feasible and scientifically sound EMRD-based indicators for national quality measurements are sparse, as shown by the National Quality Forum's measurement portfolio, in which only 2 out of 76 endorsed inpatient safety measures are EMRD-based (4). The impetus to investigate the potential of EMRD for national quality measurement is additionally underlined by experience with the National Prevalence Measurement[3] (NPM) of Falls and Pressure Ulcers, which has been conducted annually in all Swiss acute care hospitals since 2011, except for 2020 and 2021 (due to COVID-19). In this national quality measurement, qualified nurses collect defined data from the medical records as well as directly at bedside on one day per year for all inpatients who have given their oral consent to participate. Although this approach is considered the gold standard at outcome level, the personnel costs are viewed critically, as are the rather low patient participation rate of 75% and the limited clinical relevance of the results due to the cross-sectional design. It is regarded even more critically, as hospitals state that all necessary information is also available in their EMRD. Therefore, we used the NPM as a reference to investigate whether it is feasible in terms of content and technology to use EMRD for national quality measurement purposes including risk-adjusted hospital provider comparisons.

2. Methods

Design: A feasibility study was conducted with a stakeholder-centric design using quantitative and qualitative methods. Stakeholder involvement in the architecture and design of software has shown to be important, as this allows the definition of a realistic and suitable potential architecture to use existing EMRD for quality measurement, and thus makes the implementation feasible (5).

Sample: The stakeholders were recruited by applying a gatekeeper procedure (6). Contacts of the contracting authority and the research group were used to select possible participants. Study information and an invitation were sent by e-mail. Initially, all stakeholders invited agreed to participate. During the project, however, one hospital withdrew due to limited staff resources, and the person representing the patients withdrew for unknown reasons. Thus, representatives from 3 hospitals (incl. nursing experts and managers, IT specialists) and 7 other stakeholders (from health insurers [1], the hospital association [1], national regulatory authorities [3] and regional regulatory authorities [2]) participated in the project.

Data collection and analysis: The data collection and analysis can be described in 3 phases. In the 1st phase, qualitative methods were used to explore experiences with and expectations of national quality measurement, including the possibilities for using different data sources. For this purpose, an online survey with 11 open questions defined by the project team was sent to the participating stakeholders as a preparatory task in February 2021 and the summarised results were jointly discussed and validated in a two-hour online workshop in March 2021. This enabled us to review pre-existing assumptions and to jointly define the procedure followed in this study. In the workshop, the extent to which the data used in the NPM for risk adjustment are available in their electronic medical records, and which data elements that have been missing so far might be additionally available was also discussed with the representatives of the hospitals.

[3] See www.anq.ch and www.lpz-um.eu for further information on the National Prevalence Measurement

Based on the findings, the project team developed a data structure in which each variable to be exported was defined (content and technical aspects such as the data format [comma-separated values, specifying the expected separators] or the handling of non-applicable variables [empty fields vs. "none/not applicable"]. In the 2nd phase, the hospitals exported the EMRD from their systems into a Microsoft Excel file according to the defined data structure. The data were then transmitted to the project group via a secure connection, merged into one data set and analysed according to the methodological approach of the NPM to enable a comparison of the different data sources. In addition to the descriptive analysis, a so-called risk adjustment model was created. Risk adjustment is of central importance in national quality measurements to enable a fair comparison of hospital performance (7), as the total variance of outcomes between hospitals can be explained by the following variance components (V) (8): V(outcome)= V(definitions/data quality)+V(case-mix)+V(clinical care quality)+V(chance). Risk adjustment thus means controlling for differences in patient-mix between hospitals so that the remaining variability in outcome between hospitals can be attributed with some degree of certainty to differences in the clinical quality of care provided. In the 3rd phase, the results were presented by the project team to the participants and discussed and validated with them in unstructured individual online interviews (via MS-Teams) of about 30 minutes in November/December 2021.

Ethics: The EMRD was completely anonymised, which means that data are not sensitive in the sense of the Swiss Data Protection Act. It was recommended that hospitals only export EMRD from patients who have given their consent to the use of their data as part of the NPM 2019, and to have the permissibility of a data export approved internally. Given that no health-related data were collected in the survey, workshops and interviews with participants formal ethical approval and authorization from the ethics committee was not required according to the Swiss Human Research Act. All participants received written information and gave their consent for participation.

3. Results

3.1. Findings on content-related aspects

In the 1st phase, all participants agreed that the digitization efforts of the hospitals should be rendered usable for national quality measurements to efficiently use already existing data for quality development purposes. In addition, they confirmed that risk-adjusted hospital comparison is and should remain a central element of national quality measurements. Concerning the current NPM, the following limiting factors were highlighted: prevalence instead of incidence measurement, the time-delayed publication of the results and the staff effort. It was also mentioned that more quality indicators will probably be measured in the future, which further underlines the need to use EMRD.

The variables used for risk-adjusted hospital comparison in the NPM (general and risk variables listed in Table 1, column 1) were confirmed as being the important ones. No additional data items were proposed. Most of the variables are available in EMRD, although some of them are not uniformly operationalized, especially clinical variables related to falls and pressure ulcer risk assessment (Table 1, column 1). No comparable variable could be identified for care dependency. In favour of obtaining data sets that are as comprehensive as possible, minor deviations in the operationalisation of individual variables were allowed in the data structure agreed upon for data export.

Table 1. Variables of the NPM, availability of the variables in EMRD, comparison of descriptive results and comparison of fall risk factors in risk adjustment models based on NPM and EMRD.

Variables		**Descriptive results**		**Fall risk factors in risk adjustment models**	
NPM	EMRD	NPM[a] (n=13240)	EMRD (n=1094)	NPM[b]	EMRD[c] OR (95% CI)
General variables					
Age (years)	☑	71.0 (m)	72.0 (m)	↑	1.96 (1.19–3.21)
Length of stay (days)	☑	4.0 (m)	5.0 (m)	↑	1.47 (1.20–1.81)
Care dependency (CDS sum score)	☒	70.0 (m)	NA[f]	↑	NA[f]
Sex (female)	☑	49.1%	48.6%	↓	0.59 (0.31–1.12)
Surgical procedure (yes)	☑	43.9%	NA[f]	↓	NA[f]
DG: Diseases of the circulatory system (yes)	☑[d]	57.5%	64.4%		
DG: Diseases of the musculoskeletal system (yes)	☑[d]	40.0%	37.2%		
DG: Endocrine, nutritional and metabolic diseases (yes)	☑[d]	36.3%	53.4%		
DG: Diseases of the genitourinary system (yes)	☑[d]	33.2%	37.7%		
DG: Diseases of the digestive system (yes)	☑[d]	27.9%	33.2%		
DG: Diseases of the respiratory system (yes)	☑[d]	26.4%	26.6%		
DG: Neoplasms (yes)	☑[d]	22.7%	32.7%	↑	
DG: Mental, behavioural and neurodev. disorders (yes)	☑[d]	20.5%	20.3%	↑	2.28 (1.23–4.25)
DG: Diseases of the blood and blood-forming organs (yes)	☑[d]	18.0%	22.0%		
DG: Diseases of the nervous system (yes)	☑[d]	14.7%	19.8%		
DG: Certain infectious and parasitic diseases (yes)	☑[d]	13.8%	18.6%		
DG: Diseases of the skin and subcutaneous tissue (yes)	☑[d]	8.3%	9.7%		
DG: Factors influencing health status and contact with health services (yes)	☑[d]	7.3%	29.4%		
DG: Injury, poisoning and certain other consequences of external causes (yes)	☑[d]	6.7%	29.4%		
DG: Diseases of the eye and adnexa (yes)	☑[d]	6.6%	5.1%		
DG: Symptoms, signs and abnormal clinical and laboratory findings (yes)	☑[d]	5.8%	32.9%		2.10 (1.10–4.00)
DG: Diseases of the ear and mastoid process (yes)	☑[d]	2.8%	4.0%		
DG: External causes of morbidity (yes)	☑[d]	2.2%	5.6%		
(DG: Codes for special purposes) (yes)	☑	NA[f]	15.6%	NA[f]	2.03 (1.04–3.97)
Fall specific risk variables					
Risk for fall (yes)	☑[e]	29.7%	33.4%	↑	4.22 (2.01–8.84)
Sedative/psychotropic medications intake (yes)	☑[d]	37.3%	72.6%	↑	2.43 (0.82–7.20)
Outcome Variable					
Fall in hospital (yes)	☑	3.7%	4.7%		
Pressure ulcer specific risk variable					
Risk for pressure ulcer (yes)	☑[e]	31.6%	21.4%		
Outcome Variables					
Nosocomial pressure ulcer (yes)	☑	3.9%	NA[f]		
Nosocomial pressure ulcer category 2 and higher (yes)	☑	1.7%	NA[f]		

Abbreviations: NPM = National Prevalence Measurement; EMRD = electronic medical record data; OR = odds ratio; 95% CI = 95% confidence interval; CDS = Care Dependency Scale; DG = diagnosis groups according to International Statistical Classification of Diseases and Related Health Problems 10th Revision; m = median; ☑ = variable available; ↑ = fall risk increasing factor; ↓ = fall risk decreasing factor; NA = not available.

[a]The descriptive results reported here are based on the NPM 2019[4].

[b]Only factors that were selected as significant variables ($p<.05$) in the risk adjustment model in at least two of three most recent NPMs[4] are reported to ensure comparison with the more reliable factors.

[c]All variables that were selected into the risk adjustment model are reported.

[d]Information in EMRD in more detail available (per patient lists of ICD-10 Diagnosis Codes and ATC-codes).

[e]Information available in EMRD but not uniformly operationalized.

[f]Variables are either not available in the NPM or EMRD or are available in the EMRD but could only be exported correctly by 2 of the 3 hospitals and could therefore neither be considered in the descriptive (data protection reasons) nor in the risk adjustment model comparison.

[4] See NPM reports from 2017, 2018 and 2019, available at www.anq.ch

In the 2nd phase, during the data export from the electronic medical records, some content-related questions emerged. While in the NPM, for example, the pressure ulcer risk is recorded on the day of the survey, the timeliness of the risk assessment in the EMRD can vary from hospital to hospital (assessment at admission, re-assessment intervals). Further ambiguities, which will have to be further specified in the future, arose in relation to the handling of paused medications or inactive diagnoses during data export.

The descriptive analyses based on the EMRD and the NPM 2019 show - with a few exceptions - comparable results (Table 1, column 2). Five ICD-10 diagnosis groups are found much more frequently in EMRD (plus 10.0% to 27.1%), an indication that secondary diagnoses are comprehensively mapped in EMRD. The biggest difference involved "sedative/psychotropic medications intake". Since each medication is recorded in the EMRD with the corresponding Anatomical Therapeutic Chemical (ATC) classification, a much more precise and automated assignment of each medication to the combined group of sedatives/psychotropics was possible. In the NPM, the allocation is done manually based on medication list review, so an underestimation is conceivable.

Comparison of the fall risk adjustment models (Table 1, column 3) also provides insight into the data quality of EMRD. Although two important risk variables could not be included in the EMRD-based risk adjustment model (care dependency and surgical procedure), the results are comparable. Six of the selected variables proved to be relevant in previous NPMs and point in the same direction (decreasing or increasing risk) regardless of the data source used. However, there are differences in the selected ICD-10 diagnosis groups. Only one diagnosis group, "mental and behavioural disorders", corresponds to the previous NPM findings. These differences may be related to the large differences in sample sizes. However, even in the NPM, varying diagnosis groups are selected every year. As one hospital was unable to provide EMRD on pressure ulcers, the model could only be tested for the indicator of falls.

3.2. Findings on technical feasibility

The hospitals had to invest between 0.5 and 1 day to generate the data export. Different methods, partially manually and partially automated, were used. The decisive factor was whether several data sources (e.g. system for medical records and/or billing data) had to be merged, or whether all information of interest was available in the same system. Despite the jointly defined data structure, certain variables could not be exported (in the desired format). In one institution, this was due to migration to a new clinical information system. In another, it was probably due to an incorrect data query, as the data were available in the system. In the current approach, the comma-separated values (CSV) files were transferred using a Microsoft Excel file. This was assessed in the individual interviews as an appropriate method. The extent to which building a direct interface would generate a return commensurate with the effort involved was doubted.

4. Discussion

With the involvement of relevant stakeholders including representatives of 3 hospitals, it was possible to explore for the first time how EMRD related to falls and pressure ulcers can be used for national quality measurements. The results are promising from a content and technical point of view. Most of the relevant variables can be exported with little effort from existing EMRD, and data analysis yields results similar to previous

NPMs. However, the results also reveal two relevant challenges. Firstly, it became apparent that certain variables are not available in the systems (degree of care dependency) and are operationalised differently (risk assessments). A data- and literature-based definition of a minimum dataset under these conditions (e.g. proxy variable for care dependency) thus appears to be crucial. Clear specifications as to which data must be available, how operationalised and how recorded in the systems are indispensable so that the EMRD can be used for national quality measurements including risk-adjusted provider comparisons. To promote consistent and sustainable system adaptation, broad stakeholder buy-in to draw up viable national recommendations and involvement of staff who use the systems in daily practice is essential. If professionals agree on what needs to be documented to reflect real life quality of care, this will promote acceptance of system adaptations as well as data quality and completeness. Secondly, a concept to ensure data quality and comparability (incl. e.g. time of recording) needs to be developed.

In general, however, the potential of EMRD for national quality measurements is considered high, as various limitations of the NPM could be eliminated: (i) staff effort is reduced, as most data already exist digitally and only need to be converted into an exportable format by means of a query, (ii) regular data extracting and/or continuous measurement will become possible, (iii) the better use of digital opportunities allows for automation, in which results can be made available in a timely manner, up to continuous monitoring, (iv) the non-response bias is reduced if anonymised data are allowed to be exported for quality measurements without patient consent. If an automated system with interfaces to the hospitals can be set up, this system would also be flexibly adaptable to other quality indicators, which will become quite important in view of the increasing awareness of patient safety and quality of care. In the future, a promising resource for automated national quality measurements based on hospitals' EMRD could be the new decentralised data infrastructure currently being developed and implemented as part of the Swiss Personalised Health Network initiative to make relevant health data interoperable and shareable for research by defining data formats, semantics and exchange mechanisms (9). In particular, as soon as a large number of hospitals participate in the network.

References

[1] Bundesamt für Gesundheit. Evaluation der KVG-Revision im Bereich der Spitalfinanzierung - Schlussbericht des BAG an den Bundesrat. Bern: Bundesamt für Gesundheit, 2019.
[2] Vincent C, Staines A. Enhancing the Quality and Safety of Swiss Healthcare. Bern: Federal Office of Public Health, 2019.
[3] Busse R, Klazinga N, Panteli D, Quentin W. Improving healthcare quality in Europe: Characteristics, effectiveness and implementation of different strategies. 2019.
[4] National Quality Forum. National Quality Forum: Find Measures [15.03.2022]. Available from: https://www.qualityforum.org/Qps/QpsTool.aspx.
[5] Saiedian H, Dale R. Requirements engineering: making the connection between the software developer and customer. Inf Softw Technol. 2000;42(6):419-28. doi: https://doi.org/10.1016/S0950-5849(99)00101-9.
[6] Andoh-Arthur J. Gatekeepers in Qualitative Research. In: Atkinson P, Delamont S, Cernat A, Sakshaug JW, Williams RA, editors. SAGE Research Methods Foundations. London: SAGE Publications Ltd.; 2019.
[7] Bernet NS, Everink IHJ, Schols JMGA, Halfens RJG, Richter D, Hahn S. Hospital performance comparison of inpatient fall rates; the impact of risk adjusting for patient-related factors: a multicentre cross-sectional survey. BMC Health Services Research. 2022;22(1):225. doi: https://doi.org/10.1186/s12913-022-07638-7.
[8] Lilford R, Mohammed MA, Spiegelhalter D, Thomson R. Use and misuse of process and outcome data in managing performance of acute medical care: avoiding institutional stigma. The Lancet. 2004;363(9415):1147-54. doi: https://doi.org/10.1016/S0140-6736(04)15901-1.
[9] Swiss Personalized Health Network. About SPHN [15.03.2022]. Available from: https://sphn.ch/organization/about-sphn/.