



Risk-adjusted Quality Indicators for Nursing Homes using Multiple Logistic Regression

Kathrin Seibert¹ | Mathias Fünfstück² | Heinz Rothgang² |
Stefan Görres¹ | Martina Hasseler³ | Sylvia Schmidt⁴ | Werner Brannath⁴

1 University of Bremen, Institute for Public Health and Nursing Research (IPP)

2 University of Bremen, SOCIUM Research Center on Inequality and Social Policy

3 University of Heidelberg, Medical Faculty & Ostfalia University of Applied Sciences

4 University of Bremen, Competence Center for Clinical Trials (KKSB)

Outline

- **Background and Purpose**

Resident-specific quality indicators (QI) in German nursing homes and objective and design of the MoPIP-Study

- **Methods**

Approaches to risk-adjustment, selection of variables, definition of adjusted QI

- **Results**

Prognostic quality in models adjusted by stratification variable or by multiple logistic regression (MLR) and deviating QI scores of nursing homes

- **Conclusion**

Facilitating a fair comparison between nursing homes

Resident-specific Quality Indicators (QI) in German Nursing Homes I

- Resident-specific QI will be introduced in a new proceeding to measure and report nursing home care quality throughout Germany in 2019
- Suitable QI have been developed and tested entailing process and outcome indicators in three health-related dimensions:
 1. **Preservance and promotion in self-dependency**
(e.g. in functional mobility or in daily activities and arranging social contacts)
 2. **Protection from impairment and strains**
(e.g. pressure ulcera, injourus falls or unintended weight-loss)
 3. **Support for specific needs**
(e.g. use of restraints or pain assessment) (Wingenfeld et al. 2011)

Resident-specific Quality Indicators (QI) in German Nursing Homes II

Example QI 1: Preservance or improvement of mobility (none or mild cognitive impairments)

(comatose/somnolent residents and residents who suffered a major health crisis are excluded)

QI 1 Nominator:

Number of residents with improved or preserved functional mobility at a given cut-off date compared to a mobility assessment six months prior

QI 1 Denominator:

Number of all residents with an assessment of functional mobility at a given cut-off date and a mobility assessment six months prior

(Wingenfeld et al. 2011)

Scoring

- Above average
- Average
- Below average

Thresholds

are set either by

- quartiles
- means
- given proportions

Resident-specific Quality Indicators (QI) in German Nursing Homes III

- Case-mix characteristics can contribute to an imbalance in the distribution of chances to achieve positive results of care between nursing homes
 - Resident case-mix may contribute to a bias in QI measures
 - Resident case-mix may reduce comparability of nursing homes

(Wingenfeld et al. 2011; Farin 2005)

- Thus the initial developers proposed to consider resident case-mix by **stratifying residents for some outcome indicators** by:
 - Extend of cognitive impairments → none or mild vs. \geq substantial
 - Risk of pressure ulcer development → low vs. high

Objective and Design of the MoPIP-Study

(funded by the contracting parties according to § 113 Social Code, Book XI)

Objective

- Piloting of the health-related QI to assess eligibility and range for the use in a national standardized proceeding to measure and compare quality of outcomes of nursing homes
- Assessment of validity, reliability, practicability and feasibility regarding the future mandatory implementation and application in public quality reporting and external audits

Design

- 21 months Longitudinal prospective observational study
in **62 Nursing homes in 5 federal states**
- Quantitative data from **3 246 residents**

Focus of this Presentation → to demonstrate the effect of two approaches to risk-adjustment on the QI-scores of nursing homes

Approaches to Risk-Adjustment in the MoPIP-Study I

- **Stratification (as proposed by the developers of the QI-Set for some QI)**
 - Easy to apply
 - Reduces the number of included residents → may contribute to imprecision
- **Multiple Logistic Regression (as a counterproposal for all outcome QI)**
 - More than one influencing factor can be considered
 - Allows to include a larger number of residents → contributes to a higher precision
 - No influence of sample size on QI score due to standardization of the adjusted QI
 - Consistent benchmarking of nursing homes by the statistical properties of the adjusted QI
 - More subtle differentiation in QI with high numbers of nursing homes with QI Score of 0 or 1

(Rothgang et al. 2017; Wentura & Pospeschill 2015; Wingenfeld et al. 2011)

Approaches of Risk-Adjustment (RA) in the MoPIP-Study II

Stratified Approach

- Indicator-specific divide of residents into **two subgroups**:
 - none or mild vs. \geq substantial cognitive impairment
 - low vs. high risk of pressure ulcer development

MLR Approach

- Identification of significant variables not influenceable by nursing care in a **step-wise logistic regression**
- Extension of selected model: **step-wise logistic regression with forward selection** also considering partly influenceable variables

- Assessment of prognostic quality of the tested models using the receiver operating characteristic (ROC), illustrating the Area under the Curve (AUC) (**resident level data**)
- Comparison of the extent of deviation in ranking QI outcomes for nursing homes between used approaches (**aggregated data on nursing home level**)

Selection of Variables for Inclusion in the Final Regression Models

- Review of the Literature to identify variables not influenceable (e.g. age, sex, presentation of chronic illness) or partly influenceable (e.g. confinement in bed) by nursing care/nursing homes
- For each QI with resident level data:
 - **Stepwise logistic regression:** For variables not influenceable by nursing care to identify significant factors
 - **Extension of the model:** Stepwise logistic regression with forward selection including variables partly influenceable by nursing care
 - **(stepwise) Exclusion of variables:** variables which had tested statistically insignificant with a p-value $> 0,05$ (Wald-Test), variables not in accordance to the literature or with implausible direction of the influence

Definition of adjusted QI

– from resident level data to nursing home level

1. Observed indicator value O_i for residents that meet the indicator conditions as fulfilled (1) or not fulfilled (0)
2. Individual values of influencing factors are included in the final model equation of the logistic regression
→ calculation of the expected indicator value E_i
(prognosted probability for the indicator value (between 0 and 1))
3. Calculation of the adjusted QI per nursing home:

$$\text{adjusted QI} = \frac{\sum_i (O_i - E_i)}{\sqrt{(\sum_i E_i \cdot (1 - E_i))}}$$

Logistic Regression Model for QI Preservance of Mobility			
Influencing Variable	beta	Odds Ratio	p-value
Constant	1.70		
Cognitive Score	-0.11	0.89	< .001
Cerebrovascular Diseases/ Stroke	-0.52	0.60	< .001
Number of days in Hospital	-0.03	0.97	< .001
Documented fear of falling	-0.41	0.67	< .001
M. Parkinson	-0.56	0.57	0.008
Amputation of lower extremities	-0.56	0.57	0.048

Results I – Receiver Operating Characteristic (resident level data)

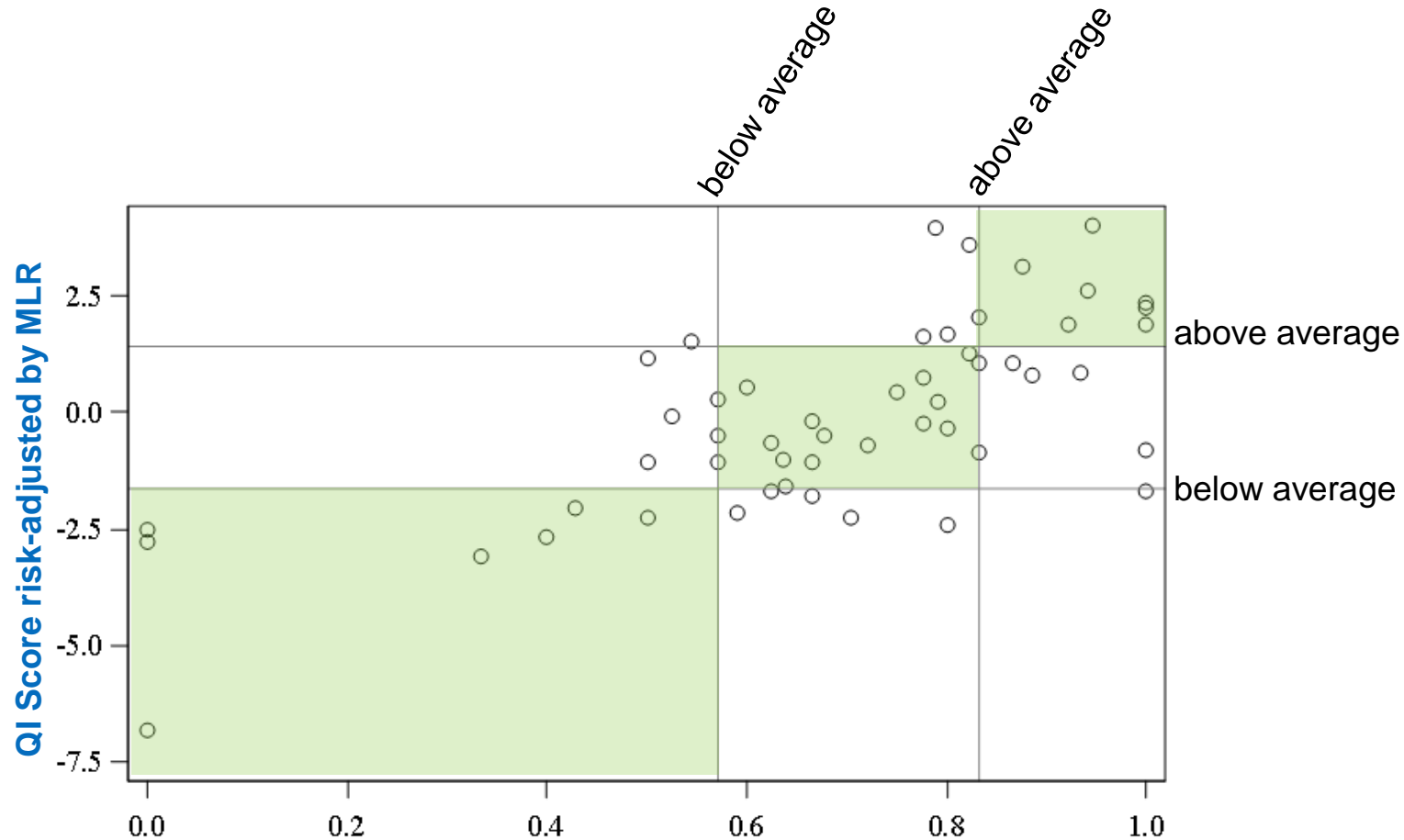
Evaluated QI	Stratification Variable	N	AUC MLR Approach	AUC Stratification variable only
Preservance of mobility	Cognitive Score	1 902	0.758	0.739
Preservance of self-dependency in daily activities	Cognitive Score	1 898	0.779	0.746
Preservance of self-dependency in social contacts		1 906	0.844	
Pressure ulcer development	Mobility Score	2 275	0.823	0.798
Injurious falls	Cognitive Score	2 068	0.697	0.548
Unintended weightloss	Cognitive Score	1 876	0.699	0.606
Restraint use		2 279	0.636	
Pain management		460	0.612	
Urinary continence		1 696	0.594	

Interpreting the Area Under the Curve (AUC) value to evaluate the suitability of the model to predict the outcome of interest (e.g. Preservance of mobility):

AUC = 1: perfectly fitted model
AUC = 0.5: indicates a completely random prognosis (independent from the data)

Results II – Comparison of Nursing Home Scores – Example QI 1

(nursing home level data)



- QI scores of nursing homes deviate depending on the approach to risk-adjustment

Scoring and Thresholds when ranking nursing homes

- Above average: facilities in the 4th quartile
- Average: facilities in the 2nd and 3rd quartile
- Below average: facilities in the 1st quartile

QI 1 Score on the basis of the original proposal for stratified subcollective

Results III – Comparison of Nursing Home Scores (nursing home level data)

- A relevant deviation in QI scores of at least 20 % of the evaluated nursing homes when using MLR in comparison to risk-adjustment by stratification/no risk-adjustment can be found for all indicators, with some indicators even reaching a proportion of about half of the evaluated nursing homes

Evaluated QI	Nursing homes with deviating QI Scores when using MLR					
	Without subcollective (SC ^a)		SC 1		SC 2	
	N	%	N	%	N	%
1 Preservance of mobility			20	38.5	16	30.8
2 Preservance of self-dependency in daily activities			20	38.5	18	34.6
3 Preservance of self-dependency in social contacts	14	26.9				
4 Pressure ulcer development			33	61.1	24	46.2
5 Injurious falls			27	51.9	19	35.8
6 Unintended weightloss			23	44.2	17	32.7
7 Restraint use	12	22.2				
8 Pain management	14	36.8				
9 Urinary continence	11	21.6				

^{a)} SC according to the developers of the original QI-Set: QI 4 SC1=low risk, SC2= high risk, all other indicators SC1= no or mild cognitive impairments, SC2=substantial cognitive impairments; Number of evaluated nursing homes between 51 and 54, for indicator 8: 38.

Conclusion I

- Prognostic quality was higher for all models adjusted by multiple logistic regression, MLR also contributed to changes in QI outcomes in at least 20 % of the observed nursing homes
- The MLR approach to risk-adjustment has proven empirically meaningful and superior to the stratified approach
- The comparison of nursing homes based on QI risk-adjusted by MLR can be considered a more fair approach for taking specific risk-profiles of nursing homes into account than risk-adjustment by stratification

Conclusion II

- Further discourse is needed on methodological issues concerning risk-adjustment when assessing nursing home quality
- Outlook 2019: When implementing a statistical risk-adjustment by MLR and developing a suitable rating classification of nursing homes based on QI outcome, the studied QI can contribute to the reporting of quality of care in German nursing homes



©University of Bremen

Risk-adjusted Quality Indicators for Nursing Homes using Multiple Logistic Regression

Kathrin Seibert¹ | Mathias Fünfstück² | Heinz Rothgang² |
Stefan Görres¹ | Martina Hasseler³ | Sylvia Schmidt⁴ | Werner Brannath⁴

1 University of Bremen, Institute for Public Health and Nursing Research (IPP)

2 University of Bremen, SOCIUM Reseach Center on Inequality and Social Policy

3 University of Heidelberg, Medical Faculty & Ostfalia University of Applied Sciences

4 University of Bremen, Competence Center for Clinical Trials (KKSB)

Contact

Kathrin Seibert

Universität Bremen, Institut für Public Health und
Pflegeforschung

Grazer Straße 2, 28359 Bremen

Phone: +49 (0)421-218 68 903

Email: kseibert@uni-bremen.de

Literature

Farin, E. (2005): Die Anwendung Hierarchischer Linearer Modelle für Einrichtungsvergleiche in der Qualitätssicherung und Rehabilitationsforschung. In: Rehabilitation 44, S. 157-164.

Rothgang, H.; Görres, S.; Fünfstück, M.; Seibert, K.; Schmitt, S.; Brannath, W.; Hasseler, M., (2017): Abschlussbericht zum Forschungsprojekt "Modellhafte Pilotierung von Indikatoren in der stationären Pflege (MoPIP), UBC/2017, Universität Bremen. *Available:* https://www.gkv-spitzenverband.de/media/dokumente/pflegeversicherung/qualitaet_in_der_pflege/indikatoren/20170320_Erganzt_Abschlussbericht_MoPIP_Universitat_Bremen.pdf [30.04.2018]

Wentura, D. & Pospeschill, M. (2015): Multivariate Datenanalyse. Eine kompakte Einführung. Springer, Wiesbaden.

Wingenfeld, K.; Engels, D.; Kleina, T.; Franz, S.; Mehlan, S. & Engel, H. (2011): Entwicklung und Erprobung von Instrumenten zur Beurteilung der Ergebnisqualität in der stationären Altenhilfe. Abschlussbericht. Hg. v. Bundesministerium für Familie, Senioren, Frauen und Jugend. Bielefeld, Köln. *Available:* http://www.bagfw.de/fileadmin/user_upload/Abschlussbericht_Ergebnisqualitaet_.pdf [30.04.2018]