### Supplementary Material Table S1– Core and peripheral elements of the INTERCARE model

The following table provides the list of core components of the nurse-led model of care, which correspond to the minimal requirements and the peripheral components, which can be tailored to each nursing home (NH) (CFIR).

| Core elements | Additional information for minimal requirements | Peripheral |
|---------------|-----------------------------------------------|-------------|
| **Interprofessional collaboration** | | |
| A structure in place to facilitate interprofessional communication (e.g. meetings) between at least two different professions. | Each NH is free to decide how communication between different professions may occur, for instance regular team meetings or unit rounds. | Number of structures in place and who involved in the communication structures. |
| Noticing a resident issue and liaising with the relevant health care professional to establish the residents’ care goal. | | |
| Interpretation of assessment results and formulation of a resident care plan in collaboration with a member of the health care team. | | |
| The INTERCARE nurse supports the communication process between physicians and health care staff. | This can occur by having a prior discussion (in person or phone call) with the care staff before they contact the physician. The INTERCARE nurse might guide the care staff to think through a situation and think about potential questions the physician may ask. | |
| **INTERCARE nurse** | | |
| According to the INTERCARE nurse’s skills and expertise residents are assessed in acute situations, when called by a member of the care team. | | |
| The INTERCARE nurse provides coaching to care staff on daily resident bedside needs. | The INTERCARE nurse supports care staff by assisting, guiding or advising them during bedside care, for instance helping staff to communicate with a resident showing aggression | Number of patients the INTERCARE nurse is responsible for in each NH. Number of units the INTERCARE nurse works on in the NH. The way and frequency in which the educational sessions are delivered. |
| The INTERCARE nurse plans educational sessions with care staff regularly. | The INTERCARE nurse can choose a topic of interest to help care staff improve their competencies and knowledge. These educational sessions can be conducted as formal presentations or by the bedside depending on the topic chosen. The INTERCARE nurse can use their own experience to help care staff manage often occurring difficult situations. | |
| The INTERCARE nurse drives team reflections for each reflection tool filled in. | The INTERCARE nurse plans informal team meetings to reflect and learn from each reflection tool, with the staff present at the time of the acute situation leading to the hospitalization. | |
| The INTERCARE nurse must have 3 years-experience in long-term-care. | | |
| Core elements | Additional information for minimal requirements | Peripheral |
|---------------|-----------------------------------------------|------------|
| A position of 60% minimum per 80 beds for which the INTERCARE nurses are responsible for. | The CGA includes the following dimensions:  
• Physical dimension  
• Functional dimension  
• Social dimension  
• Economic dimension  
• Mental dimension | Each INTERCARE nurse is free to define how involved they are and the degree of responsibility they have for each dimension.  
Any care staff can be involved in the 5 dimensions of the CGA, corresponding to their degree of training and experience |
| **Comprehensive geriatric assessment (CGA)**  
The INTERCARE nurse collaborates with the leadership and/or interprofessional team to discuss and define which assessment instrument they work with, for each of the 5 CGA dimensions in their institution, within the first 6 months of the implementation of the model. | The INTERCARE nurse’s role is clearly defined with regards to their input in the 5 dimensions of CGA.  
The INTERCARE nurse is involved and supports the care team in integrating the 5 dimensions of CGA in daily practice.  
The INTERCARE nurse ensures that residents and relatives are involved in the decision-making process. | |
| **Advance care planning (ACP)**  
For every newly admitted resident, the following points must be documented in the residents’ records:  
  o Do Not Resuscitate order  
  o Do not hospitalize order  
  o Use of antibiotics | Provides information and guidance to the care team about the 5 different dimensions and can suggest how each dimension can be assessed and evaluated. | Presence of physician during initial conversation and subsequent conversations with residents/relatives.  
Degree of involvement of the NH staff in ACP discussions  
The INTERCARE nurse is in charge of ensuring that every question is clarified with residents and relatives.  
The INTERCARE nurse checks for each new resident admission if the resident has an advance care plan. |
| The leadership team decides who is responsible in the NH to guide the ACP process.  
For residents in unstable condition before weekends: physician orders and care plans are clarified (Notfallplan), by the appointed responsible person(s) in each NH. | | |
| **Evidence-based tools**  
**STOP & WATCH**  
The INTERCARE nurse is responsible for the implementation of the STOP&WATCH and supervises the usage of the Stop and Watch STOP&WATCH tool in daily practice. | None | |
| Core elements                                                                                           | Additional information for minimal requirements                                                                 | Peripheral                                                                                           |
|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Implementation of the STOP&WATCH tool on each participating unit, within the first 6 months of implementation of the model. |                                                                                                                 | Degree of penetration of the STOP&WATCH tool, e.g. used by housekeeping staff, therapists.          |
| Used by nurse assistants to inform the responsible person about changes in resident condition.          |                                                                                                                 | Internal process of how the tools are handled and stored after completion.                          |
| It is clearly defined who will use the STOP&WATCH tool, if extended to other staff.                     |                                                                                                                 | Implementation of other tools such as care pathways, to help guide assessment for chronic conditions.|
| All staff using the STOP&WATCH must be trained.                                                        |                                                                                                                 | Using the tools to hand over information non-verbally, e.g. emails, fax.                            |
| The situation for which the STOP&WATCH tool is used, is recorded in the resident's documentation, if a change in resident situation has been recognized. |                                                                                                                 |                                                                                                       |
| The nurse responsible should perform the adequate assessment after being given the STOP&WATCH.          |                                                                                                                 |                                                                                                       |
| The transmission of the STOP&WATCH tool is either indirect (e.g. storage in a designated compartment for the person in charge of the day) or it is handed over directly to the person in charge of the day / the responsible qualified nurse. |                                                                                                                 |                                                                                                       |
| The STOP&WATCH tool must be filled in and, if necessary, the appropriate letters should be marked as soon as a change in the residents’ condition has been identified. |                                                                                                                 |                                                                                                       |
| General information about the resident and the person who filled in the instrument must be added.       |                                                                                                                 |                                                                                                       |
| All unit staff are informed about implementation of the STOP&WATCH tool.                               |                                                                                                                 |                                                                                                       |
| Distribution of the STOP&WATCH notepads to all employees who will use the tool.                         |                                                                                                                 |                                                                                                       |
| **ISBAR**                                                                                              | None                                                                                                           | None                                                                                                 |
| The INTERCARE nurse is responsible for the implementation and monitoring of the use of ISBAR and in giving feedback. | None                                                                                                           |                                                                                                       |
| Implementation of the ISBAR tool on each participating unit within the first 6 months of implementation of the model. | None                                                                                                           |                                                                                                       |
| Used by registered nurses in communicating with physicians and with the INTERCARE nurse in acute situations. | None                                                                                                           |                                                                                                       |
| It is clearly defined who will use the ISBAR tool, if extended to the members of the care team.         | None                                                                                                           |                                                                                                       |
| All staff using the ISBAR tool must be trained.                                                        | None                                                                                                           |                                                                                                       |
| Distribution of the ISBAR Pocket version to all registered nurses and all staff trained to use the ISBAR tool. | None                                                                                                           |                                                                                                       |
| Core elements | Additional information for minimal requirements | Peripheral |
|---------------|-----------------------------------------------|-------------|
| All unit staff is informed about implementation of the ISBAR tool. | | |
| **Data-driven quality improvement** | | Each NH can decide who participates in the SPC/Benchmarking discussion. Each NH can decide who takes part in the discussion and completing one PDCA cycle |
| Continuous data collection for all hospitalisations and emergency department (ED) visits, with exports every 3 months for SPC charts and 6 months for benchmarking. | | |
| A member of the leadership team with or without INTERCARE nurse should discuss the SPC charts and benchmarking reports together and prepare discussion points for leadership meetings with the research group. | | |
| A member of the leadership team and INTERCARE nurse should meet and discuss which steps are needed to improve quality improvement and complete one PDCA cycle for one identified quality indicator. | For an identified issue, a Plan-Do-Check-Act cycle is carried out. Plan Pre-defined persons should think about how they will analyze a situation, how information will be collected, what the goal of the planned change is. Do Pre-defined persons should think about how they plan to carry out the change, what is needed, from whom, and who is responsible for guiding the change. Check Pre-defined persons should reflect on what was initially planned and what happened during the change. Act Pre-defined persons should discuss and describe which improvement measures were implemented and if change occurred. | |
Table S2: Implementation strategies used to promote the up-take of INTERCARE

**Implementation strategies**: The “how to” component of changing healthcare practice or the means and methods of adopting and sustaining interventions, 8 strategies.

Summary of implementation strategies used to support and facilitate the implementation of the core elements of the intervention.

| Implementation strategy                                      | Implementation strategy and definition according to Powell et al | Description for INTERCARE                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **International and national nursing home visits**          | Visit other sites                                                | During a preliminary phase A of the INTERCARE project, 15 case studies were conducted in Swiss NHs to assess structures, processes, outcomes as well as barriers and facilitators to facilitate the implementation and planned strategies to reduce barriers and ensure the sustainability of the intervention. International models were also visited to help gain an insight into ANP roles and model differences. |
| **Stakeholder meetings**                                   | Conduct local consensus discussion                                | A stakeholder group formed of nursing home leaders, physicians, Swiss policymakers and cantonal association representatives, are included in important decisions regarding the intervention, such as decision making regarding the appropriateness of the clinical tasks and responsibilities of the new nurse expert role, defining the core elements of the intervention and to help identify barriers and facilitators for the implementation of the intervention, as well as discussing the outcomes for the Swiss setting. Bi-annual meetings to exchange and discuss major points relating to the intervention. |
| **Binding contract between NHs and research site**         | Obtain formal commitments                                         | A signed contract was established between the research site and the participating NHs.                                                                                                                                                                                                                                                                       |
| **Determining core and peripheral components of the nurse-led model of care** | Promote adaptability                                              | The model consists of 6 core elements and peripheral elements which allows the intervention to be tailored to meet the specific intervention site needs. Core elements are considered to be mandatory to be implemented and peripheral components can be adapted individually. Core elements were developed and described to reach the specific clinical outcomes of the study. |
| Implementation strategy                  | Implementation strategy and definition according to Powell et al.¹ | Description for INTERCARE                                                                                                                                                                                                 |
|-----------------------------------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Nursing home leadership training and support** | Assess for readiness and identify barriers and facilitators  
Assess various aspects of an organization to determine its degree of readiness to implement; barriers that may impede implementation, and strengths that can be used in the implementation effort. | Specifically, tailored training sessions for NH leadership and additional staff such as NH accountants, physicians and nurses to ensure buy-in and tailoring of the nurse-led model to individual NHs through the identification of barriers and facilitators. 1 full day and 2 half-day follow-up training sessions were offered to all 11 NHs participating. |
| **INTERCARE nurse blended learning curriculum** | Create new clinical teams  
Change who serves on the clinical team, adding different disciplines and different skills to make it more likely that the clinical innovation is delivered (or is more successfully delivered) | Implementation of the INTERCARE nurses acquires new competencies and skills expanding the usual profile. Thus, position profile was developed and new competencies were described to ensure the ability to deliver the intervention. |
| **Conduct ongoing training**              | Plan for and conduct training in clinical innovation in an ongoing way | Continuous education of INTERCARE nurses starting before the project and is further developed throughout the project.                                                                                                                                                                 |
| **Resource sharing agreements**           | Develop partnerships with organizations that have the resources needed to implement the innovation | Partnerships with nursing educational institutions who have geriatric expertise and/or experience in curriculum development.                                                                                                                                                         |
| **Make training dynamic**                 | Vary the information delivery methods to cater to different learning styles and  
1. work contexts, and shape the training in the innovation to be interactive | Blended learning curriculum including: e-learnings, readings, tests, reflections and case studies and face-to-face meeting accounts for variation in delivering the education. It maximizes the learning outcomes considering that adults have different learning styles and working environments. |
| Implementation strategy | Implementation strategy and definition according to Powell et al.1 | Description for INTERCARE |
|-------------------------|---------------------------------------------------------------|-----------------------------|
| Develop and distribute educational materials | Various materials as e.g. guidelines on how to implement evidence-based tools, algorithms how and when to use Reflection tools, staff handouts to inform and powerpoint presentations to educate staff about the communication instruments, manuals on how to enter residents' data into data management system, will be developed and distributed. All materials should help facilitate the implementation and adherence to the intervention. All materials were posted on an online learning platform and/or sent by email. |
| Audit and provide feedback | Quarterly exports for quality indicators and on-going collection of data for hospitalisations to help NHs identify where better quality of care can be provided and which actions they may take. This will be discussed during the 2 monthly meetings in each NH. |
| Provide local technical assistance | Project coordinator available to provide assistance and ensure good communication between NHs and the research team. Face-to-face two monthly meetings with the leadership teams. |
| Provide ongoing consultation | A networking platform is available for NHs to share experiences and documentation, as well as 2 monthly in-person meetings and 2 weekly phone calls to support the INTERCARE nurse during the implementation process. |

1. Powell BJ, Waltz TJ, Chinman MJ, et al. A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. *Implement Sci* 2015;10:21. doi: 10.1186/s13012-015-0209-1 [published Online First: 2015/04/19]
Table S3. Nursing home characteristics

| Nursing homes participating in the INTERCARE project (n= 11) | Missing |
|-------------------------------------------------------------|---------|
| **Location of nursing homes**                               | 0       |
| Located in an urban area, n (%)                            | 8 (72.7)|
| Located in a rural area, n (%)                             | 2 (18.2)|
| Located in a suburban area, n (%)                          | 1 (9.1)|
| **Legal status**                                            | 0       |
| Privately funded, n (%)                                     | 9 (81.8)|
| Publicly funded, n (%)                                      | 2 (18.2)|
| **Bed count**                                               |         |
| All long-term beds, median (IQR)                           | 120 (114-161)| 0|
| N of beds participating in INTERCARE, median (IQR)         | 88 (80-103)| 1|
| **Physician model**                                         | 0       |
| Physician(s) on-site responsible for ≥ 80% of residents, n (%) | 3 (27.2)|
| External physician(s) responsible for ≥ 80% of residents, n (%) | 4 (36.4)|
| Mixed model, n (%)                                          | 4 (36.4)|
| **INTERCARE nurses (n=19)**                                |         |
| Age, years, median (IQR)                                   | 39 (30.5-51)| 0|
| INTERCARE nurses per NH, median (IQR)                      | 1 (1-2) | 0|
| Bed responsibility per INTERCARE nurse, median (IQR)       | 95 (80-121.5)| 0|
Supplementary Material Table S4: Effect estimation of the INTERCARE nurse-led model on unplanned transfers (controlled) using linear mixed regression model adjusted by NH as random effects.

| Parameter                     | Estimate (logodds) | Standard Error | t-Value (df) | P-value | Odds ratio |
|-------------------------------|--------------------|----------------|--------------|---------|------------|
| Intercept                     | -4.171 (-6.525 – -1.818) | 1.0563         | -3.95 (10)   | 0.0027  |            |
| Months pre-intervention       | 0.510 (0.252 – 0.767)   | 0.1314         | 3.88 (403e3) | 0.0001  | 1.665 (1.287 – 2.153) |
| Months post-intervention      | -0.511 (-0.773 – -0.250) | 0.1333         | -3.84 (403e3) | 0.0001  | 0.600 (0.462 – 0.779) |
| CPS                           | -0.231 (-0.447 – -0.014) | 0.1105         | -2.09 (403e3) | 0.0369  | 0.794 (0.640 – 0.986) |
| Age                           | -0.035 (-0.048 – -0.022) | 0.0067         | -5.02 (403e3) | <.0001  | 0.966 (0.953 – 0.979) |
| Gender                        | 0.420 (-0.200 – 1.040)   | 0.3165         | 1.33 (403e3)  | 0.1845  | 1.522 (0.819 – 2.830) |

df = degrees of freedom; CPS = Cognitive Performance Scale
**Supplementary Material Table S5:** Effect of the INTERCARE nurse-led model on all transfers (10 months prior to intervention start until 20 months post-intervention start)

| Parameter                             | Estimate (95% confidence interval) | Standard Error | t-Value (df) | Pr > |t| |
|---------------------------------------|------------------------------------|----------------|--------------|-------|---|
| Intercept ($\alpha$)                  | 0.032 (-0.325 – 0.390)             | 0.161          | 0.20 (10)    | <.0001 |
| Time since baseline ($\beta_1$)       | 0.037 (0.009 – 0.064)              | 0.014          | 2.61 (273)   | 0.0010 |
| Time after intervention start ($\beta_2$) | -0.065 (-0.116 – -0.015)         | 0.026          | -2.56 (273)  | 0.011  |

Logarithmically transformed outcome variables can be interpreted as percentage changes per 1-unit difference in the predictor variable. This means that before the intervention, an increase in all transfers of $100 \times \beta_1 = 100 \times 0.037$, or 3.7% per month was observed. After the intervention, a decrease in monthly unplanned referrals set in, at a rate of $(\beta_1 + \beta_2 = 0.037 – 0.065) \times 100 = -2.8\%$ per month.

df = degrees of freedom
Supplementary Material Figure S1: Nursing home and resident recruitment flowchart
Supplementary Material Figure S2: Predicted total transfers per 1000 resident care days (+ 95% confidence intervals) calculated from validation routine data.
Supplementary Material Figure S3: Hospital transfer rates across the routine validation dataset compared to the CASTOR EDC dataset.

Note: Same-day unplanned transfers from the CASTOR EDC data from residents with informed consent are omitted, to be comparable to the validation data; Lines fitted using penalized B-spline smoothing.
**Supplementary Material Figure S4:** Planned and unplanned transfer rates post implementation of INTERCARE.