DAYS SPENT AT HOME AND MORTALITY AFTER CRITICAL ILLNESS: A CLUSTER ANALYSIS USING NATIONWIDE DATA

Guillaume L. Martin, MD, Alice Atramont, MD, Marjorie Mazars, MSc, Ayden Tajahmady, MD, Emin Agamaliyev, PhD, Mervyn Singer, FRCP, Marc Leone, MD, Matthieu Legrand, MD

PII: S0012-3692(22)03997-6

DOI: https://doi.org/10.1016/j.chest.2022.10.008

Reference: CHEST 5324

To appear in: *CHEST*

Received Date: 16 April 2022

Revised Date: 13 September 2022

Accepted Date: 5 October 2022

DAYS SPENT AT HOME AND MORTALITY AFTER CRITICAL ILLNESS: A CLUSTER ANALYSIS USING NATIONWIDE DATA

Guillaume L MARTIN, MD (1), Alice ATRAMONT, MD (1), Marjorie MAZARS, MSc (1), Ayden TAJAHMADY, MD (1), Emin AGAMALIYEV, PhD (1), Mervyn SINGER, FRCP (2), Marc LEONE, MD (3, 4), Matthieu LEGRAND, MD (4, 5, 6)

1. Caisse Nationale de l'Assurance Maladie, Paris, France
2. Bloomsbury Institute for Intensive Care Medicine, Division of Medicine, University College London, London, United Kingdom
3. Aix-Marseille University, Assistance Publique Hôpitaux de Marseille, Department of Anesthesia and Intensive Care Unit, Hospital Nord, Marseille, France
4. Société Française d'Anesthésie et de Réanimation (SFAR), Paris, France
5. Department of Anesthesia and Perioperative Care, Division of Critical Care Medicine, UCSF, San Francisco, USA
6. INI-CRCT network, Nancy, France

Corresponding author

Pr Matthieu Legrand, Department of Anesthesia and Perioperative Care, Division of Critical Care Medicine, UCSF, San Francisco, USA. matthieu.legrand@ucsf.edu, ORCID: 0000-0001-9788-5316

Word count: 3750
Abstract word count: 270

Conflicts of interests

MS reports other from NewB, other from Amormed, other from Biotest, other from Fresenius, grants from Apollo Therapeutics, other from Roche, personal fees from Safeguard Biosystems, personal fees from Aptarion Biotech, personal fees from Pfizer, grants from UCL Technology Fund, outside the submitted work. MLeo received fees for lectures (AOP) and consulting (Ambu, Gilead, LFB); MLeg reports no conflict of interest. GLMartin reports grants and personal fees from Synapse Medicine, outside the submitted work.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Key words:

Intensive care; trajectory; outcome; PICS

Abbreviation list:

ICU, intensive care unit
PICS, post-ICU syndrome
ACH, acute care hospitals
PW, psychiatric wards
RF, rehabilitation facilities
HAH, hospital at home
SNH, skilled nursing homes
PMSI, Programme de Médicalisation des Systèmes d’Information
CNAM, Caisse Nationale de l’Assurance Maladie
SAPS II, Simplified Acute Physiology Score II

Abstract

Background. Beyond the question of short-term survival, days spent at home could be considered a patient-centered outcome in critical care trials.

Research question. What are the days spent at home and healthcare trajectories during the year after surviving critical illness?

Study Design and Methods. Data were extracted on adult survivors spending at least two nights in a French intensive care unit (ICU) during 2018 who were treated with invasive mechanical ventilation and/or vasopressors or inotropes. Trauma, burn, organ transplant, stroke and neurosurgical patients were excluded. Stays at home, death, hospitalizations were reported before and after ICU stay, using state sequence analysis. An unsupervised clustering method was performed to identify cohorts based on post-ICU trajectories.

Results. Of 77,132 ICU survivors, 89% returned home. In the year post-discharge, these patients spent a median 330 (IQR 283-349) days at home. At one year, 77% of patients were still at home and 17% had died. Fifty-one percent had been re-hospitalized and 10% required a further ICU admission. Forty-eight percent used rehabilitation facilities and 5.7% hospital at home. Three clusters of patients with distinct post-ICU trajectories were identified. Patients in cluster 1 (68% of total) survived and spent most of the year at home (338 (323-354) days). Patients in cluster 2 (18%) had more complex trajectories but most could return home (91%), spending 242 (174-277) days at home. Patients in cluster 3 (14%) died with only 37% returning home for 45 (15-90) days.

Interpretation. Many patients had complex healthcare trajectories after surviving critical illness. Wide variations in the ability to return home after ICU discharge was observed between clusters, which represents an important patient-centered outcome.

Stay in an intensive care unit (ICU) represents a major life event, impacting the physical, cognitive and mental health of many survivors.[1,2,3,4,5] Beyond the legitimate question of short-term survival, outcomes research in critical care is increasingly focusing on longer-term survival and quality of life. In this regard, the post-ICU syndrome (PICS) has been increasingly recognized as a major clinical entity.[1,6,7] Defined as impairments in cognition, mental health, and physical function following critical care, it affects 33-99% of survivors.[8] While small cohorts have reported quality of life or functional status after critical illness, the ability of the patient to return home and their subsequent healthcare trajectories in large populations remains underexplored.[7,9–11] Data from large-scale population-based cohorts are needed to better delineate patient needs and to inform patients, relatives and policy-makers.[12–14]

The main objective of this study was to report outcomes and healthcare trajectories during the year following ICU discharge in adult patients admitted to French ICUs in 2018, using state sequence analysis. We focused on their ability to return home, days spent at home and healthcare trajectories.

Methods

<u>Data Source</u>

France has a mandatory public health insurance system that covers the entire population, *i.e.* 67 million inhabitants. The National Health Data System (Système National des Données de Santé, SNDS) comprehensively collects anonymized individual health care consumption data, reimbursed to beneficiaries of the various French public health insurance schemes.[15] The SNDS includes outpatient data (pharmacy reimbursement claims, healthcare professional visits and laboratory or imaging claims), and is linked to data collected on public and private hospital admissions via the Programme de Médicalisation des Systèmes d’Information (PMSI), the national hospital discharge database. The PMSI comprises information regarding admissions to acute care hospitals (ACH), psychiatric wards (PW) use of rehabilitation facilities (RF) and hospital at home (HAH). The SNDS is also linked to a specific database for skilled nursing homes (SNH). The SNDS collects demographic data, date of death and long-term chronic diseases (LTD) eligible for 100% reimbursement of healthcare expenditure. Hospital stays in ACH are classified by the *Groupes Homogènes de Malades* (GHM) system, a French adaptation of diagnosis-related groups. LTD and hospital diagnoses are coded according to the International Statistical Classification of Diseases, 10th Revision. Procedures are coded according to the *Classification Commune des Actes Médicaux,* a French classification of medical procedures.

The use of SNDS data by the *Caisse Nationale de l'Assurance Maladie* (CNAM), the French National Health Insurance Fund, has been approved by decree and by the French data protection authority (*Commission Nationale de l'Informatique et des Libertés* [CNIL]). CNAM has permanent access to SNDS data in application of the provisions of article R. 1461-12 of the French public health code.

Study population selection

Inclusion criteria were patients aged 18 years and older, admitted to a French adult ICU between January 1st 2018 and December 31st 2018, for at least two consecutive nights, requiring invasive mechanical ventilation and/or vasopressors or inotropes. Patients admitted to the ICU for trauma, burn injuries, organ transplant, stroke or intracranial surgery were excluded from analysis as these causes of admission intrinsically affect the patient's ability to return home and reflect highly specific populations with distinct trajectories. Patients with no healthcare reimbursement in 2017 or with data linkage problems were also excluded. For each patient, if several acute care hospital (ACH) admissions met the selection criteria, the first was considered the index stay. As the study focused on post-ICU trajectories, only patients discharged alive following the index ICU admission were included.

Data collection and statistical analysis

Data were extracted on age, sex, and selected pre-existing comorbidities identified by algorithms applied to the patients' 2017 data. These algorithms, developed by CNAM, combine inpatient diagnoses, long-term disease information and pharmacy reimbursement claims, and are applied annually to each beneficiary providing information on 58 health conditions.[16]

For the index stay, the cause of hospitalization (based on the GHM classification, summarized into 10 categories), ICU procedures, length of ICU stay, and the Simplified Acute Physiology Score II (SAPS II) on ICU admission were identified.

For each patient, a daily state sequence was created to analyze care pathways in the 365 days preceding and the 365 days following ICU discharge (baseline date, Supplement Figure 1). A sequence refers to the daily succession of the different events (states) defining the patient's trajectory. Subsequent states were collected: death, hospital stays in ACH (at least one night), RF, PW (only full-time hospitalization), HAH and SNH stays. Among ACH stays, ICU admissions were specifically identified. When neither hospitalized nor deceased, patients were considered to be at home. Patients with SNH stays after the index stay were considered at home if they were already in a SNH before the index stay. When multiple states overlapped on the same day, we used the following priority rule to define the chosen state: Death > ICU > ACH > RF > PW > HAH > SNH > Home. To facilitate visualization and clustering operations (see below), the daily state sequence was aggregated in a weekly state sequence, selecting the most frequent state presented by each patient during each week of the year preceding and following ICU discharge (52 weeks per year). If an equal number of events occurred during the same week for concurrent states, the previously described priority rule was used to define the weekly state.

Descriptive statistics were reported based on the individual daily state sequences (for each state: number of patients with at least one admission, number of admissions, cumulative length of admissions). Healthcare trajectories before and after ICU discharge were represented using distribution plots (transversal distribution of the different states each week) and sequence index plots (superposition of all the individual weekly state sequences).

Based on the post-ICU weekly state sequences, an unsupervised clustering method was used to identify groups of patients with similar trajectories following ICU discharge. The (dis)similarity between sequences was first measured: pairwise distances were computed between individual sequences by optimal matching, using the Longest Common Subsequence (LCS) method.[17] The Partition Around Medoids (PAM) clustering algorithm was then applied, using previously computed distances.[18] This algorithm is intended to find a prespecified number of k representative sequences, called medoids, and attributes other sequences to the closest medoid. It aims to reduce the sum of dissimilarities between the medoid (center of the cluster) and the attributed sequences. The number of clusters was determined according to both statistical criteria and clinical appraisal of the clustering results. Sensitivity analyses using other sequence dissimilarity methods (Optimal Matching with different costs, Hamming distance),[17] and clustering algorithms (Hierarchical Ascendant Classification, using Ward's method) were conducted. Overall, results were similar across analyses, and the approach combining LCS and PAM was chosen for its robustness.

A multinomial logistic regression model was then used to assess baseline factors associated with the subsequently created clusters. Multivariable analysis was adjusted for baseline factors considered clinically relevant.

Data from the year before ICU discharge that was used as an exploratory analysis aimed to describe whether it differed with post ICU-clusters.

Results are presented as percentage or median and interquartile range (IQR) or odds ratios (OR) and 95% confidence intervals (CI). Analyses were performed using SAS software (version 9.4, SAS Institute Inc) and R version 3.5.2 (packages TraMineR version 2.0-11 and WeightedCluster version 1.4 for sequence analysis and clustering).[17,18]

Results

<u>Baseline characteristics</u>

Of 222,896 patients admitted to a French adult ICU during the study period, 96,177 met the selection criteria. Of these, 20% died before ICU discharge, leaving 77,132 patients in the final cohort (Table 1 and Supplement Figure 2). Baseline patient characteristics are shown in Table 1. Median age was 67 years (IQR 57-75), with 58% patients older than 65 years and 27% over 75 years (Table 1). The most frequent comorbidities were diabetes (24%), chronic respiratory disease (19%), psychiatric disorders (14%), chronic heart failure (10%), and active cancer (10%). The median SAPS II score was 41 (30-55). Post-operative care was the main reason for admission (30% cardiac, 23% non-cardiac), followed by respiratory diseases (14%). Invasive mechanical ventilation, vasopressors or inotropes, and renal replacement therapy were used in 83%, 65% and 9.1% of patients, respectively. The median length of index ACH stay (including contiguous ACH stays) was 18 days (11-33). The median ICU length of stay was 5 days (3-10); 24% of ICU stays exceeded 10 days. Patients were admitted directly to intensive or transitional care units, or via the emergency department for 62% of index stays.

<u>Healthcare trajectories after ICU discharge</u>

Three clusters were identified based on the patients' post-ICU trajectories (Table 2 and 3). Figure 1 shows the state distribution plots and sequence index plots of care pathways before and after ICU discharge for all patients and for each of the three clusters.

Among the 77,132 patients discharged alive from the index ICU stay, 4,360 (5.7%), 6,124 (7.9%) and 7,424 (9.6%) died within the 30, 60 and 90 days after ICU discharge, respectively. The median duration before death was 71 (19-180) days. Six percent of patients (n = 4,615) died during the index ACH stay (and contiguous ACH stays).

Eighty-nine percent of patients returned home at some point during the year following ICU discharge for a median cumulative duration of 330 (283-349) days (Table 2). They returned home 18 (7-37) days after ICU discharge. During the one-year follow-up, 51% of patients required re-hospitalization in an ACH for a median 11 (4-25) days, and 10% an ICU readmission for 5 (2-11) days. About 44% of acute care readmissions were through the emergency department, or transitional/intensive care units. The main reasons for readmissions in ACH were cardiovascular diseases (16%), non-cardiac surgery (16%), gastrointestinal diseases (13%) and respiratory diseases (12%). Cardiac surgery, which represented 30% of the index stays, only accounted for 2% of the ACH readmissions. The main reasons for ICU readmissions were respiratory diseases (25%), non-cardiac surgery (22%) and cardiovascular diseases (12%).

Regarding other stays, 48% of patients were admitted at least once to RF for 29 (21-54) days, 5.7% had HAH stays, 5.2% were admitted to a PW and 2% to a SNH facility. At one-year post-ICU discharge, 77% of patients were at home and 17% had died.

Over the year preceding the index ICU stay, 99% were at home for a median cumulative duration of 351 (333-358) days, 56% were hospitalized in an ACH for a median 7 (3-18) days and 4.9% had been admitted to an ICU for a median 4 (2-9) days (Supplementary Table 1 and Figure 2).

Healthcare trajectories among clusters

We identified three clusters with very distinct characteristics and outcomes (Figures 1 and 2). Cluster 1 (n=52,254, 68%) was characterized by an early return to home and, mostly, a hospital-free trajectory for the year following ICU discharge. Patients could be discharged home in 99.8% of cases for a median 338 (323-354) days. The median time before home discharge was 13 (6-28) days. At one year, 98% were still alive and 95% were at home. Nonetheless, 47% required re-hospitalization in an ACH a median 2 (1-3) times for a median of 8 (3-17) days; 6.5% were readmitted to an ICU for a median 4 (2-8) days, and 42% were admitted to RFs for 22 (19-29) days. Cluster 1 included the highest rate of patients admitted to a PW (6.3%, for 33 (14-79) days). HAH or SNH admissions were infrequent. The progression of 'ACH-to-Home' (23%) or 'ACH-to-RF-to-Home' (17%) were the two main distinct state sequences in this cluster. Over the year preceding ICU discharge, 99% of patients in this cluster were at home for a median of 354 (343-359) days. Fifty-four percent had been hospitalized in an ACH for 6 (2-14) days and 5.8% stayed in RFs (Supplementary Table 1).

Cluster 2 (n=13,775, 18%) gathered patients with more complex and heterogeneous pathways. Despite the heterogeneity of the individual sequences, the transversal state distribution showed that in the first three weeks following ICU discharge, patients were mostly in an ACH. Over the following 10 weeks, 40-57% were in RFs and, subsequently, home discharge was achieved in 43-70% (Figure 1A). In this cluster, despite more frequent re-hospitalizations, 91% of patients returned home for 242 (174-277) days. The median time before discharge home was 70 (37-112) days. At one-year post-ICU discharge, 92% had survived and 70% were at home. Of note, 71% required re-hospitalization at least once in an ACH during the year following ICU discharge, with 2 (1-4) stays for 21 (8-45) days. In addition, 89%, 12%, 8% and 4% were admitted to RFs (for 66 (45-111) days), HAH, SNH or PWs, respectively. With regard to the year preceding ICU discharge, 99% of these patients were at home, 56% were hospitalized in an ACH for a median 10 (4-25) days and 5.6% required ICU admission for 5 (2-12) days (Supplementary Table 1). Sixteen percent spent 37 (20-72) days in RFs.

Cluster 3 (n=11,103, 14%) gathered patients who died during the year post-ICU discharge. Over the year following ICU discharge, only 37% returned home for a median of 45 (15-90) days with none at home at one year post-ICU discharge (Table 2). The median time before discharge home was 16 (8-38) days. The progression from 'ACH-to-Death' was the most frequent distinct state sequence in this cluster, accounting for 39% of the individual daily sequences. Forty-four percent were re-hospitalized in an ACH for a median of 19 (8-37) days with a median of 2 (1-3) stays, 28% were admitted to RFs for 29 (14-55) days, and 11% had HAH stays for 28 (11-67) days. During the year preceding ICU discharge, 98% were at home, 66% required at least one ACH stay for 16 (7-32) days, 7.9% an ICU admission for 5 (2-10) days and 16% an admission to RFs for 31 (16-59) days (Supplementary Table 1).

Risk factors to belong to a cluster

Patients in clusters 2 and 3 were older and had more comorbidities than patients in cluster 1 (Table 3). They were less frequently hospitalized for cardiac surgery, had longer index ICU stays, higher SAPS II scores and more frequently required renal replacement therapy, blood transfusion, mechanical circulatory support, gastrostomy and tracheotomy than patients in cluster 1. Compared with cluster 1, patients in cluster 2 were more often women whereas patients in cluster 3 were more often men. These results were confirmed for variables included in the multivariable analysis (Table 3 and Figure 3). Compared with cluster 1, the risk associated with being in cluster 3 increased from 1.65 [1.30-2.08] for patients aged 35-44 years to 21.58 [16.83-27.65] for patients over 90 years compared with patients aged 18-34 years. The comorbidities most strongly associated with cluster 3 were active cancer (OR = 2.27 [2.14-2.42]), liver disease, dementia and heart failure with an OR around 1.8 (Figure 3). Using cardiac surgery as the reference, all other reasons for hospitalization were positively associated with cluster 3 and also for cluster 2 except respiratory diseases and poisoning. Gastrostomy was a strong risk factor to belong to clusters 2 and 3.

Discussion

In this large retrospective population study of critically ill adults surviving an admission to a French ICU in 2018, 89% returned home for a median duration of 330 (283-349) days while 17% died over the year following ICU discharge. Re-hospitalizations in acute care units and ICUs were needed for 51% and 10% of patients, respectively. There was wide heterogeneity in their ability to return home. We identified three clusters reflecting three distinct post-ICU trajectories. Many patients had complex trajectories with alternating periods at home and hospital. Importantly, most patients who died during the year following discharge could not return home and those who did, managed to stay home for only a short period.

We previously reported that ICU survivors had a high risk of dying over subsequent years.[19] In this present study, we confirmed an ICU mortality of approximately 20% and an additional mortality rate of 17% in the year following ICU discharge. Albeit important, mortality may not be the worst outcome considered by patients or their relatives.[14,20,21] Several observational studies reported poor quality of life of altered functional status after surviving a critical illness.[4,5,22,23] Only a few randomized controlled trials have explored functional outcomes as a crucial endpoint. The conventional ventilation or extracorporeal membrane oxygenation (ECMO) for severe adult respiratory failure (CESAR) trial, for instance, explored the impact of ECMO in patients with severe acute respiratory distress syndrome on death or severe disability at 6 months.[24] Recently, ability to return home and hospital free days have been proposed as significant patient-centered outcomes in ICU survivors.[25,26] Implementing strategies to accelerate and improve recovery and the ability to return home are advocated by both critical illness survivors and clinicians.[27]

Quality of life in ICU survivors should be viewed as a main goal of ICU management. In the year preceding the ICU discharge, 99% of our cohort were at home for a median of 351 (333-358) days, although 56% were hospitalized in an acute care unit for 7 (3-18) days during 1 (1-3) stays and 5% had an ICU stay. During the year following ICU discharge, 89% of the patients returned home, 51% were re-hospitalized in an ACH for 11 (4-25) days and 10% spent 5 (2-11) days in an ICU. Of note, half of the patients were admitted at least once to a RF for a median of 29 (21-54) days, which represents a significant increase in healthcare resource utilization. Importantly, the days spent at home during the year preceding admission was not a major discriminant of post-ICU trajectories.

Large variations in post-discharge trajectories were identified in the three different clusters. Cluster 1 gathered survivors who returned home following ICU discharge and survived although many required several acute hospitalizations and 42% were admitted to a RF. Cluster 2 included patients who had more complex healthcare trajectories with 71% requiring a new acute hospitalization and 17% an ICU readmission. The majority were admitted to long-term care facilities. Cluster 3 mainly comprised patients who died during the year following ICU discharge, with only 37% able to return home (43% including receipt of HAH) for a short period of time. Patients in clusters 2 & 3 were more likely to have prolonged ICU stays (>10 days), receive renal replacement therapy, have a tracheotomy or gastrostomy performed.[28] Most had complex trajectories with large utilization of healthcare resources. Of note, in the general population in France in 2018, around 15/1000 inhabitants were admitted for hospitalizations in RF, and 107/1000 inhabitants for overnight hospitalizations in ACH. Admissions to RF vary across hospitals and regions, depending on ease of access or the population profile, and are decided on a case-by-case basis by physicians, with no specific economic or clinical criteria.

Our study reports at a national scale the trajectories of patients after ICU discharge and adds to the literature of post-ICU outcomes. Among 1083 Medicare survivors of sepsis, of whom only 38% required intensive care admission, 63% were readmitted in the first year after discharge, spending a median 16 days (IQR, 2–45) in an inpatient healthcare facility.[25] Among patients with septic shock, only a third of survivors had not returned to independent living by 6 months after discharge. In our study, the identification of clusters of patients provides important insights into the population more likely to return home after an ICU stay and those more likely to have complex trajectories with a requirement for complex care While these data are not intended for decision-making at the individual level, they nonetheless provide valuable information on the healthcare intensity of different populations after an ICU admission. Most of the patients who died during the year post-ICU discharge never went home, except for short periods, and spent most of their time in acute care units and RFs. Of note, 98% of them were at home in the year preceding ICU admission, excluding such criteria as a predictor of post-ICU outcomes. These results reinforce the need for accurate predictive and prognostic tools in patients discharged from the ICU.[29]

Cluster 2 gathers populations most likely to benefit from strategies aimed at improving post-ICU outcomes. While large scale, multicenter studies are still lacking, interdisciplinary and collaborative rehabilitation interventions are feasible and may improve post-ICU outcomes. In a randomized controlled trial, early mobilization in patients with sepsis was associated with an increased likelihood of being discharged directly home (51% *vs.* 27%, p <0.001).[30] Long-term consequences of critical illness, including respiratory and cardiovascular complications, neuromuscular weakness, neurological disorders, cognitive decline, depression, post-traumatic stress disorders and decompensation or progression of underlying comorbidities of critical illness, have been increasingly recognised.[22,23,31–37] This has been reported as an umbrella syndrome - PICS - corresponding to a global health impairment that includes physical, psychological and cognitive symptoms after critical illness.[8] PICS may explain the high utilization of healthcare resources post-ICU discharge, especially RF and psychiatric hospitalization. This last form of hospitalization was needed by 6% of cluster 1 patients. In the French and European Outcome reGistry in Intensive Care Units (FROG-ICU) cohort, 22% and 19%, respectively, showed symptoms of anxiety or depression.[38,39] In a prospective, multicenter cohort, a history of anxiety or depression, prolonged duration of mechanical ventilation and inability to home discharge were associated with long-term disability.[12]

The methodology used in our study has several strengths. First, we used a nationwide administrative database with an excellent capture of healthcare utilization. Around 7% of patients were excluded due to absence of reimbursed healthcare or linkage issues making it impossible to follow healthcare trajectories. We excluded patients with specific causes of index hospital stay admission that could have had a major impact on post-ICU trajectories. Sequence analysis allowed us to analyze healthcare trajectories, considering the different states and their chronological progression, and could thus complement the focus on specific outcomes. Different sequence dissimilarity measures were tested, as well as a hierarchical ascendant clustering method. Although the three-cluster typology remained broadly similar, clusters 1 and 2 could vary in size.

Limitations of our study include the observational design, which prevents any causal association. This study focused on hospitalization data to define healthcare trajectories; ambulatory care requirements were not analyzed. Moreover, clinical information, functional status or markers of quality of life are not directly available in the SNDS to assess whether patients who returned home were independent for daily life activities. Hospital bed availability, regional resource differences and healthcare provider preferences could have impacted upon healthcare trajectories.

Overall, our study highlights the use of massive claim database to explore long-term outcomes in critically ill patients, including the probability to return home which is a major patient-centered outcome. Future articles may further detail predictors of such long term outcomes.

Interpretation

Most patients surviving a critical illness could return home. Many patients had complex healthcare trajectories compared to the year preceding their index ICU admission but most patients who died after ICU discharge never return home or remain there for short periods highlighting the need to better identify this subgroup of patients. Days at home should be considered an important patient-centered outcome in future critical care trials.

Acknowledgments

Matthieu Legrand takes responsibility for the content of the manuscript, including the data and analysis. GLM, AA had full access to all of the data in the study ad performed the statistical analysis. GLM, AA, MM, AT, EA, MS, MLeone, MLegrand contributed substantially to the study design, data analysis and interpretation, and the writing of the manuscript.

Take-Home Point

Study Question: How many days patients spent at home during the year after surviving critical illness?
Results: Among patients surviving an intensive care unit (ICU) stay, 89% returned home (for a median 330 (IQR 283-349) days) but with wide variability between clusters, and only 37% of patients who died after ICU discharge could return home for 45 (15-90) days.
Interpretation: Many patients had complex healthcare trajectories after surviving critical illness with large variability in the ability to return home.

References

1. Gajic O, Ahmad SR, Wilson ME, Kaufman DA. Outcomes of critical illness: what is meaningful? *Curr Opin Crit Care* 2018;24(5):394–400.

2. Hatch R, Young D, Barber V, Griffiths J, Harrison DA, Watkinson P. Anxiety, Depression and Post Traumatic Stress Disorder after critical illness: a UK-wide prospective cohort study. *Crit Care* 2018;22(1):310.

3. Legrand M. Negative trials in critical care medicine and the hurdles. *Lancet Respir Med* 2018;6(10):e53.

4. Herridge MS, Cheung AM, Tansey CM, et al. One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med* 2003;348(8):683–693.

5. Cheung AM, Tansey CM, Tomlinson G, et al. Two-year outcomes, health care use, and costs of survivors of acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2006;174(5):538–544.

6. Hashem MD, Nallagangula A, Nalamalapu S, et al. Patient outcomes after critical illness: a systematic review of qualitative studies following hospital discharge. *Crit Care* 2016;20(1):345.

7. Iwashyna TJ, Ely EW, Smith DM, Langa KM. Long-term cognitive impairment and functional disability among survivors of severe sepsis. *JAMA* 2010;304(16):1787–1794.

8. Kosilek RP, Schmidt K, Baumeister SE, Gensichen J, SMOOTH Study Group. Frequency and risk factors of post-intensive care syndrome components in a multicenter randomized controlled trial of German sepsis survivors. *J Crit Care* 2021;65:268–273.

9. Elliott D, McKinley S, Alison J, et al. Health-related quality of life and physical recovery after a critical illness: a multi-centre randomised controlled trial of a home-based physical rehabilitation program. *Crit Care* 2011;15(3):R142.

10. Gandotra S, Files DC, Shields KL, Berry M, Bakhru RN. Activity Levels in Survivors of the ICU. *Phys Ther* 2021;pzab135.

11. Geense WW, Boogaard M van den, Peters MAA, et al. Physical, Mental, and Cognitive Health Status of ICU Survivors Before ICU Admission: A Cohort Study. *Crit Care Med* 2020;48(9):1271–1279.

12. Jouan Y, Grammatico-Guillon L, Teixera N, et al. Healthcare trajectories before and after critical illness: population-based insight on diverse patients clusters. *Ann Intensive Care* 2019;9(1):126.

13. Jones TK, Fuchs BD, Small DS, et al. Post-Acute Care Use and Hospital Readmission after Sepsis. *Ann Am Thorac Soc* 2015;12(6):904–913.

14. Auriemma CL, Harhay MO, Haines KJ, Barg FK, Halpern SD, Lyon SM. What Matters to Patients and Their Families During and After Critical Illness: A Qualitative Study. *Am J Crit Care* 2021;30(1):11–20.

15. Tuppin P, Rudant J, Constantinou P, et al. Value of a national administrative database to guide public decisions: From the système national d'information interrégimes de l'Assurance Maladie (SNIIRAM) to the système national des données de santé (SNDS) in France. Rev Epidemiol Sante Publique 2017;65 Suppl 4:S149–S167.

16. Rachas A, Gastaldi-Ménager C, Denis P, et al. The Economic Burden of Disease in France From the National Health Insurance Perspective: The Healthcare Expenditures and Conditions Mapping Used to Prepare the French Social Security Funding Act and the Public Health Act. *Med Care* 2022;60(9):655–664.

17. Studer M. WeightedCluster Library Manual: A practical guide to creating typologies of trajectories in the social sciences with R. 2013 [cited 2022 Jan 27];Available from: https://www.centre-lives.ch/fr/bibcite/reference/84

18. Gabadinho A, Ritschard G, Müller NS, Studer M. Analyzing and Visualizing State Sequences in R with TraMineR. *Journal of Statistical Software* 2011;40:1–37.

19. Atramont A, Lindecker-Cournil V, Rudant J, et al. Association of Age With Short-term and Long-term Mortality Among Patients Discharged From Intensive Care Units in France. *JAMA Netw Open* 2019;2(5):e193215.

20. Auriemma CL, O'Donnell H, Jones J, et al. Patient perspectives on states worse than death: A qualitative study with implications for patient-centered outcomes and values elicitation. *Palliat Med* 2022;36(2):348–357.

21. Rubin EB, Buehler AE, Halpern SD. States Worse Than Death Among Hospitalized Patients With Serious Illnesses. *JAMA Intern Med* 2016;176(10):1557–1559.

22. Wunsch H, Guerra C, Barnato AE, Angus DC, Li G, Linde-Zwirble WT. Three-year outcomes for Medicare beneficiaries who survive intensive care. *JAMA* 2010;303(9):849–856.

23. Hill AD, Fowler RA, Pinto R, Herridge MS, Cuthbertson BH, Scales DC. Long-term outcomes and healthcare utilization following critical illness--a population-based study. *Crit Care* 2016;20:76.

24. Peek GJ, Mugford M, Tiruvoipati R, et al. Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial. *Lancet* 2009;374(9698):1351–1363.

25. Prescott HC, Langa KM, Liu V, Escobar GJ, Iwashyna TJ. Increased 1-year healthcare use in survivors of severe sepsis. *Am J Respir Crit Care Med* 2014;190(1):62–69.

26. Groff AC, Colla CH, Lee TH. Days Spent at Home - A Patient-Centered Goal and Outcome. *N Engl J Med* 2016;375(17):1610–1612.

27. Auriemma CL, Taylor SP, Harhay MO, Courtright KR, Halpern SD. Hospital-Free Days: A Pragmatic and Patient-centered Outcome for Trials among Critically and Seriously Ill Patients. *Am J Respir Crit Care Med* 2021;204(8):902–909.

28. Law AC, Stevens JP, Choi E, et al. Days out of Institution after Tracheostomy and Gastrostomy Placement in Critically Ill Older Adults. *Ann Am Thorac Soc* 2022;19(3):424–432.

29. Schofield-Robinson OJ, Lewis SR, Smith AF, McPeake J, Alderson P. Follow-up services for improving long-term outcomes in intensive care unit (ICU) survivors. *Cochrane Database Syst Rev* 2018;11:CD012701.

30. Major ME, Dettling-Ihnenfeldt D, Ramaekers SPJ, Engelbert RHH, Schaaf M van der. Feasibility of a home-based interdisciplinary rehabilitation program for patients with Post-Intensive Care Syndrome: the REACH study. *Crit Care* 2021;25(1):279.

31. Legrand M, Rossignol P. Cardiovascular Consequences of Acute Kidney Injury. *N Engl J Med* 2020;382(23):2238–2247.

32. Gayat E, Hollinger A, Cariou A, et al. Impact of angiotensin-converting enzyme inhibitors or receptor blockers on post-ICU discharge outcome in patients with acute kidney injury. *Intensive Care Med* 2018;

33. Dick A, Liu H, Zwanziger J, et al. Long-term survival and healthcare utilization outcomes attributable to sepsis and pneumonia. *BMC Health Serv Res* 2012;12:432.

34. Jackson JC, Ely EW, Morey MC, et al. Cognitive and physical rehabilitation of intensive care unit survivors: results of the RETURN randomized controlled pilot investigation. *Crit Care Med* 2012;40(4):1088–1097.

35. Wilson ME, Barwise A, Heise KJ, et al. Long-Term Return to Functional Baseline After Mechanical Ventilation in the ICU. *Crit Care Med* 2018;46(4):562–569.

36. Huang M, Parker AM, Bienvenu OJ, et al. Psychiatric Symptoms in Acute Respiratory Distress Syndrome Survivors: A 1-Year National Multicenter Study. *Crit Care Med* 2016;44(5):954–965.

37. Neufeld KJ, Leoutsakos J-MS, Yan H, et al. Fatigue Symptoms During the First Year Following ARDS. *Chest* 2020;158(3):999–1007.

38. Gayat E, Cariou A, Deye N, et al. Determinants of long-term outcome in ICU survivors: results from the FROG-ICU study. *Crit Care* 2018;22(1):8.

39. Bastian K, Hollinger A, Mebazaa A, et al. Association of social deprivation with 1-year outcome of ICU survivors: results from the FROG-ICU study. *Intensive Care Med* 2018;44(12):2025–2037.

Tables

Table 1. Characteristics of patients and index stays

	n	%
Number of patients	77132	100
Age, years		
18-34	3335	**4.3**
35-44	3881	**5.0**
45-54	8736	**11.3**
55-64	16279	**21.1**
65-69	11872	**15.4**
70-74	12141	**15.7**
75-79	9564	**12.4**
80-84	7005	**9.1**
85-89	3465	**4.5**
≥ 90	854	**1.1**
Age in years, median (IQR)	67 (57-75)	
Sex		
Male	49914	**64.7**
Female	27218	**35.3**
Comorbidities		
Heart failure	7850	**10.2**
Cerebrovascular disease	4541	**5.9**
Diabetes	18626	**24.1**
Active cancer	7960	**10.3**
Dementia	1236	**1.6**
Chronic respiratory disease	14784	**19.2**
End-stage renal disease	1610	**2.1**
Liver disease	3834	**5.0**
Psychiatric disease	11121	**14.4**
Reason for hospitalization		
Cardiac surgery	23157	**30.0**
Non-cardiac surgery	18036	**23.4**
Respiratory diseases	11076	**14.4**
Cardiovascular diseases	8031	**10.4**
Poisoning	4264	**5.5**
Neurological diseases (except stroke)	3486	**4.5**
Gastrointestinal diseases	3153	**4.1**
Renal or metabolic diseases	2396	**3.1**
Infectious diseases	1546	**2.0**
Miscellaneous	1987	**2.6**
Length of index ACH stay in days, median (IQR)*	18 (11-33)	
Length of ICU stay in days, median (IQR)	5 (3-10)	

2-3 days (Quartile 1)	27387	35.5
4-5 days (Quartile 2)	15065	19.5
6-10 days (Quartile 3)	16401	21.3
> 10 days (Quartile 4)	18279	23.7
ICU procedures*		
Invasive mechanical ventilation	64263	83.3
Vasopressors or inotropes	50271	65.2
Noninvasive mechanical ventilation	25388	32.9
Fluid resuscitation	16000	20.7
Renal replacement therapy	7012	9.1
Transcutaneous temporary cardiac stimulation	4704	6.1
Administration of blood products	4438	5.8
Transcutaneous drainage of a pericardial collection	2114	2.7
Cardiopulmonary resuscitation with intubation	1338	1.7
Emergency external electrical cardioversion	1071	1.4
Mechanical circulatory support	938	1.2
Tracheostomy	3686	4.8
Gastrostomy	1614	2.1
SAPS II, median (IQR)	41 (30-55)	
SAPS II, missing data	71	

*including contiguous ACH stays

Table 2. Description of hospital and SNH stays, home stays and death in the year (365 days) following ICU discharge, for all patients and by cluster

	All patients	Cluster 1	Cluster 2	Cluster 3
Number of patients	77132	52254	13775	11103
ACH				
Index stay (and contiguous stays)				
Number of patients with at least one stay, n (%)	73264 (95.0)	49043 (93.9)	13441 (97.6)	10780 (97.1)
Cumulative LOS, days, median (IQR)*	10 (6-18)	8 (5-13)	20 (11-35)	14 (7-26)
Rehospitalization(s) in ACH				
Number of patients with at least one stay, n (%)	39130 (50.7)	24489 (46.9)	9765 (70.9)	4876 (43.9)
Number of stays, median (IQR)*	2 (1-3)	2 (1-3)	2 (1-4)	2 (1-3)
Cumulative LOS, days, median (IQR)*	11 (4-25)	8 (3-17)	21 (8-45)	19 (8-37)
ICU				
Number of patients with at least one stay, n (%)	7638 (9.9)	3408 (6.5)	2381 (17.3)	1849 (16.7)
Number of stays, median (IQR)*	1 (1-1)	1 (1-1)	1 (1-1)	1 (1-1)
Cumulative LOS, days, median (IQR)*	5 (2-11)	4 (2-8)	6 (3-13)	6 (3-15)
RF				
Number of patients with at least one stay, n (%)	37256 (48.3)	21898 (41.9)	12292 (89.2)	3066 (27.6)
Number of stays, median (IQR)*	1 (1-2)	1 (1-1)	2 (1-2)	1 (1-2)
Cumulative LOS, days, median (IQR)*	29 (21-54)	22 (19-29)	66 (45-111)	29 (14-55)
HAH				
Number of patients with at least one stay, n (%)	4359 (5.7)	1456 (2.8)	1718 (12.5)	1185 (10.7)
Number of stays, median (IQR)*	1 (1-2)	1 (1-1)	1 (1-3)	1 (1-2)
Cumulative LOS, days, median (IQR)*	35 (15-86)	24 (12-45)	68 (29-138)	28 (11-67)
PW				
Number of patients with at least one stay, n (%)	4045 (5.2)	3285 (6.3)	574 (4.2)	186 (1.7)
Number of stays, median (IQR)*	1 (1-2)	1 (1-2)	2 (1-3)	1 (1-2)
Cumulative LOS, days, median (IQR)*	36 (15-87)	33 (14-79)	61 (27-129)	28 (12-85)
SNH**				
Number of patients with at least one stay, n (%)*	1635 (2.1)	161 (0.3)	1102 (8.0)	372 (3.4)
Cumulative LOS, days, median (IQR)*	157 (49-270)	67 (21-218)	215 (104-282)	53 (21-128)
Home				
Number of patients with at least one stay, n (%)	68873 (89.3)	52158 (99.8)	12557 (91.2)	4158 (37.4)

Cumulative LOS, days, median (IQR)*	330 (283-349)	338 (323-354)	242 (174-277)	45 (15-90)
Number of patients at home at 1 year, n (%)	59123 (76.7)	49414 (94.6)	9709 (70.5)	0 (0.0)
Home (including HAH)				
Number of patients with at least one stay, n (%)	69774 (90.5)	52173 (99.8)	12826 (93.1)	4 775 (43.0)
Cumulative LOS, days, median (IQR)*	330 (285-349)	338 (324-354)	249 (187-282)	49 (18-96)
Number of patients at home at 1 year, n (%)	59595 (77.3)	49526 (94.8)	10049 (73.0)	20 (0.2)
Death				
Number of deaths, n (%)	13292 (17.2)	1150 (2.2)	1104 (8.0)	11038 (99.4)
Cumulative length, days, median (IQR)***	294 (185-346)	71 (34-116)	74 (41-110)	316 (249-351)

*Among patients with at least one stay; ** Patients with SNH stays after the index stay were considered at home if they were already in SNH before the index stay; ***Among deceased patients; ACH: acute care hospital; HAH: hospital at home; ICU: intensive care unit; IQR: interquartile range; LOS: length of stay; PW: psychiatric ward; RF: rehabilitation facilities; SNH: skilled nursing home.

Table 3. Characteristics of patients and index stays by cluster, and factors associated with clusters in multinomial logistic regression models

*including contiguous ACH stays; CI: confidence interval; ICU: intensive care unit; IQR: interquartile range; SAPS: simplified acute physiology score

	Cluster 1		Cluster 2		Cluster 3		Cluster 2		Cluster 3	
	n	%	n	%	n	%	(Ref. = Cluster 1)		(Ref. = Cluster 1)	
Numl										5% CI
Age category, years										
18-34	2765	5.3	454	3.3	116	1.0	1.00	Ref.	1.00	Ref.
35-44	3064	5.9	586	4.3	231	2.1	1.09	[0.95-1.26]	1.70	[1.35-2.15]
45-54	6595	12.6	1431	10.4	710	6.4	1.28	[1.13-1.44]	2.49	[2.02-3.06]
55-64	11553	22.1	2790	20.3	1936	17.4	1.39	[1.24-1.56]	3.78	[3.10-4.61]
65-69	8081	15.5	2172	15.8	1619	14.6	1.63	[1.44-1.83]	4.81	[3.94-5.87]
70-74	8218	15.7	2130	15.5	1793	16.1	1.63	[1.45-1.84]	5.74	[4.70-7.01]
75-79	6108	11.7	1815	13.2	1641	14.8	1.93	[1.71-2.18]	7.36	[6.02-9.00]
80-84	4014	7.7	1397	10.1	1594	14.4	2.26	[1.99-2.56]	10.57	[8.64-12.95]
85-89	1535	2.9	817	5.9	1113	10.0	3.30	[2.87-3.79]	16.36	[13.27-20.17]
≥ 90	321	0.6	183	1.3	350	3.2	3.65	[2.94-4.52]	24.37	[18.99-31.26]
Age, years, median (IQR)	66 (55-74)		68 (59-77)		72 (64-80)					
Sex										
Male	33945	65.0	8656	62.8	7313	65.9	1.00	Ref.	1.00	Ref.
Female	18309	35.0	5119	37.2	3790	34.1	1.09	[1.04-1.13]	0.89	[0.84-0.93]
Comorbidities										
Heart failure	4210	8.1	1615	11.7	2025	18.2	1.31	[1.23-1.40]	1.79	[1.68-1.92]
Cerebrovascular disease	2670	5.1	976	7.1	895	8.1	1.20	[1.11-1.30]	1.16	[1.06-1.26]
Diabetes	11677	22.3	3618	26.3	3331	30.0	1.13	[1.08-1.18]	1.17	[1.11-1.23]
Active cancer	4293	8.2	1368	9.9	2299	20.7	1.06	[0.99-1.14]	2.22	[2.09-2.36]
Dementia	539	1.0	277	2.0	420	3.8	0.98	[0.93-1.03]	1.10	[1.04-1.16]
Chronic respiratory disease	9063	17.3	2789	20.2	2932	26.4	0.95	[0.83-1.09]	1.35	[1.18-1.55]
End-stage renal disease	906	1.7	312	2.3	392	3.5	1.36	[1.25-1.49]	1.89	[1.73-2.07]
Liver disease	2100	4.0	786	5.7	948	8.5	1.34	[1.27-1.43]	1.26	[1.18-1.35]
Psychiatric disease	7298	14.0	2176	15.8	1647	14.8	1.34	[1.15-1.56]	1.81	[1.57-2.08]
Reason for hospitalization										
Cardiac surgery	19264	36.9	3175	23.0	718	6.5	1.00	Ref.	1.00	Ref.
Non-cardiac surgery	10509	20.1	4369	31.7	3158	28.4	1.72	[1.61-1.83]	5.27	[4.79-5.80]
Respiratory diseases	6699	12.8	2021	14.7	2356	21.2	1.03	[0.95-1.11]	5.65	[5.09-6.26]
Cardiovascular diseases	4699	9.0	1542	11.2	1790	16.1	1.42	[1.32-1.53]	6.83	[6.17-7.57]
Poisoning	3738	7.2	308	2.2	218	2.0	0.54	[0.47-0.61]	2.44	[2.06-2.89]
Neurological diseases (except stroke)	2246	4.3	752	5.5	488	4.4	1.62	[1.46-1.79]	5.48	[4.79-6.28]
Gastrointestinal diseases	1786	3.4	540	3.9	827	7.4	1.30	[1.17-1.46]	8.44	[7.46-9.56]
Renal or metabolic diseases	1395	2.7	452	3.3	549	4.9	1.27	[1.12-1.43]	6.44	[5.60-7.39]
Infectious diseases	840	1.6	314	2.3	392	3.5	1.68	[1.46-1.94]	8.99	[7.70-10.49]
Miscellaneous	1078	2.1	302	2.2	607	5.5	1.42	[1.24-1.64]	14.03	[12.19-16.15]
Length of index ACH stay in days, median (IQR)*	15 (10-24)		37 (21-61(		29 (17-49)					
Length of ICU stay, days, median (IQR)	4 (2-8)		8 (4-18)		7 (4-15)					

2-3 days (Quartile 1)	21979	42.1	3021	21.9	2387	21.5	1.00	Ref.	1.00	Ref.
4-5 days (Quartile 2)	11036	21.1	2115	15.4	,914	17.2	1.25	[1.17-1.33]	1.23	[1.15-1.32]
6-10 days (Quartile 3)	10646	20.4	2985	21.7	2770	24.9	1.68	[1.58-1.78]	1.54	[1.44-1.64]
> 10 days (Quartile 4)	8593	16.4	5654	41.0	4032	36.3	3.49	[3.29-3.71]	2.54	[2.37-2.72]
ICU procedures										
Invasive mechanical ventilation	44382	84.9	11610	84.3	8271	74..5				
Vasopressors or inotropes	31553	60.4	10162	73.8	8556	77.1				
Noninvasive mechanical ventilation	15688	30.0	5353	38.9	4347	39.2	0.99	[0.94-1.03]	0.97	[0.92-1.02]
Fluid resuscitation	9485	18.2	3618	26.3	2897	26.1	1.14	[1.09-1.20]	1.08	[1.03-1.14]
Renal replacement therapy	3354	6.4	2031	14.7	1627	14.7	1.34	[1.25-1.43]	1.31	[1.22-1.41]
Transcutaneous temporary cardiac stimulation	3809	7.3	716	5.2	179	1.6	1.00	[0.91-1.10]	0.84	[0.71-1.00]
Administration of blood products	,485	4.8	1154	8.4	799	7.2	1.29	[1.19-1.40]	1.36	[1.24-1.49]
Transcutaneous drainage of a pericardial collection	1684	3.2	345	2.5	85	0.8	1.19	[1.05-1.35]	0.95	[0.75-1.20]
Cardiopulmonary resuscitation with intubation	695	1.3	347	2.5	296	2.7	1.12	[0.97-1.29]	1.36	[1.16-1.58]
Emergency external electrical cardioversion	589	1.1	291	2.1	191	1.7	1.19	[1.02-1.40]	1.15	[0.96-1.39]
Mechanical circulatory support	516	1.0	335	2.4	87	0.8	1.82	[1.56-2.12]	1.76	[1.37-2.25]
Tracheostomy	1,533	2.9	1,258	9.1	895	8.1	1.65	[1.51-1.80]	1.52	[1.37-1.67]
Gastrostomy	398	0.8	668	4.8	548	4.9	3.67	[3.21-4.21]	4.31	[3.73-4.98]
SAPS II, median (IQR)	38 (28-51)		46 (34-59)		51 (40-64)					
SAPS II, missing data	48	0.1	12	0.1	11	0.1				

Figures

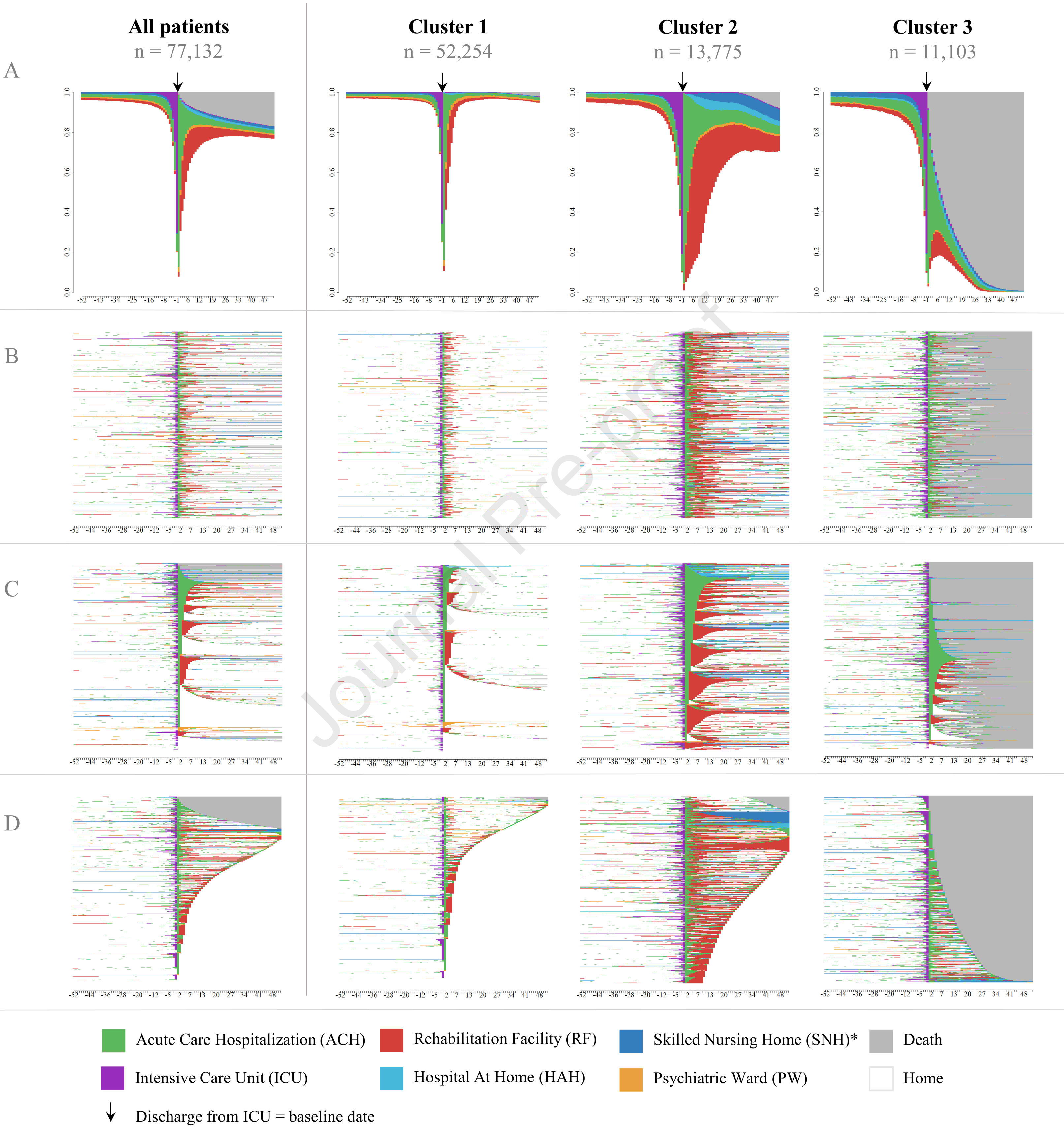
Figure 1. State distribution plot (A) and sequence index plots (B, C, D) of healthcare trajectories during the 52 weeks before and after ICU discharge, for all patients and by cluster

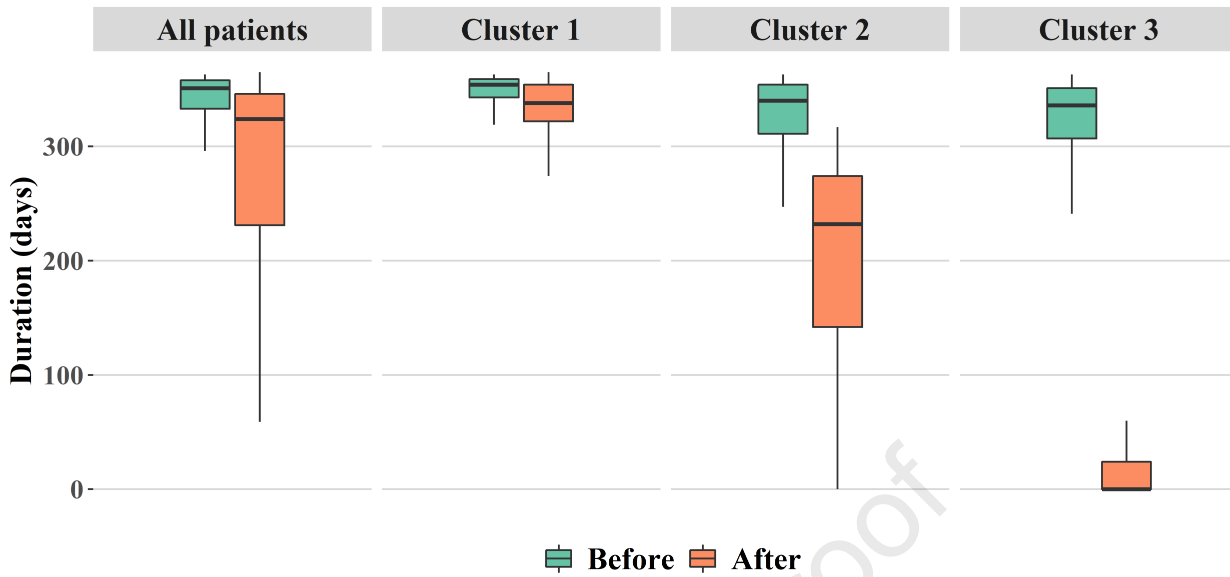
A: State distribution plots (transversal distribution of the different states each week); B, C, D: Sequence index plots (superposition of the longitudinal individual sequences of patients): unsorted (B), sorted by states from start of the post-ICU trajectory (C) and sorted by states from end (D)
*Patients already admitted to SNH before ICU admission are represented as "Home" after ICU discharge.
In all figures, the *x* axis represents week numbering, before and after ICU discharge. The baseline date (ICU discharge) is set at the beginning of week 1. In Figure 1A, the *y* axis represents the proportion of patients. In Figures 1B, 1C and 1D, 1 line represents 1 patient sequence.

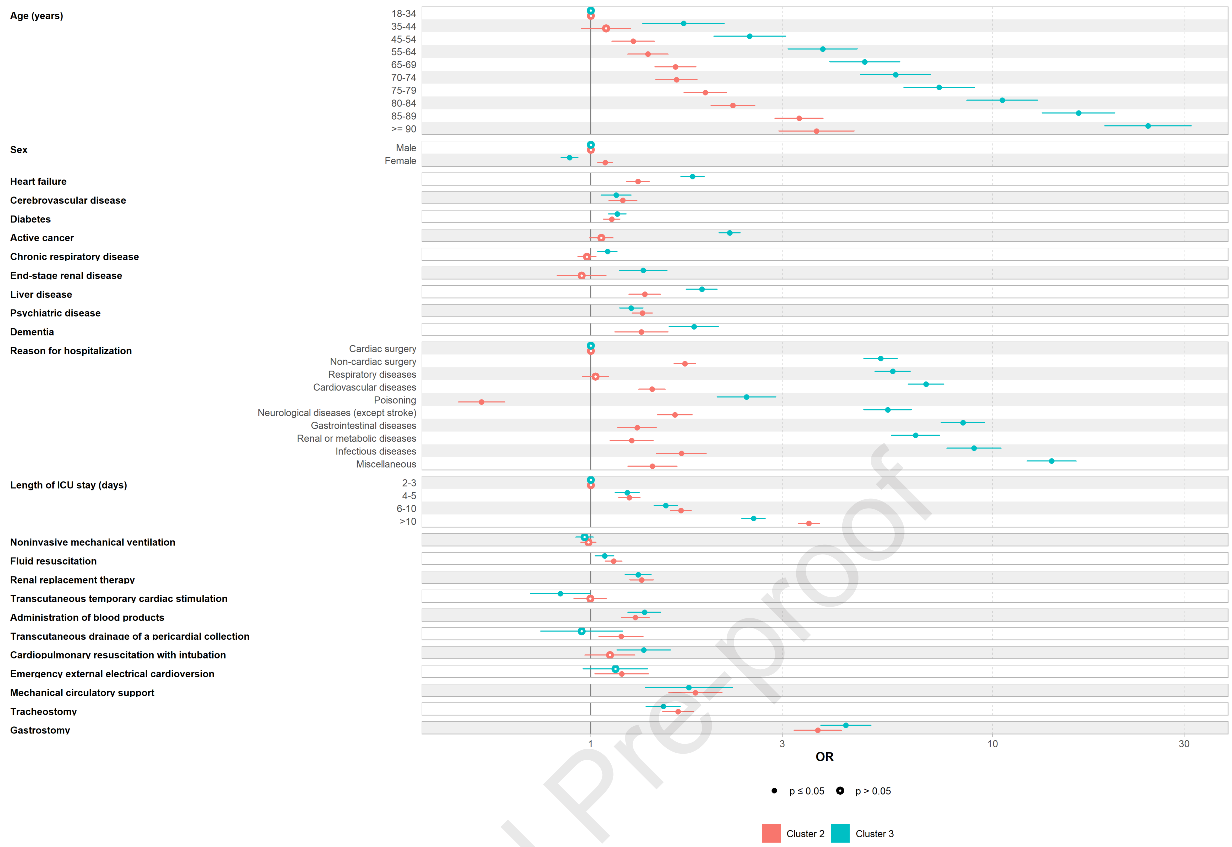
Figure 2. Distribution of the number of days spent at home during the year before and the year after ICU discharge, for all patients and by cluster

During the year before ICU discharge "Home" included skilled nursing home (SNH); during the year after ICU discharge, "Home" included SNH only for patients who were already in SNH before ICU discharge.
All patients, including without any return to home (i.e. number of days at home = 0) are plotted.

Figure 3. Factors associated with being in clusters 2 or 3 in multinomial logistic regression models with cluster 1 taken as a reference


All patients
n = 77,132
Cluster 1
n = 52,254
Cluster 2
n = 13,775
Cluster 3
n = 11,103
A
B
C
D
Acute Care Hospitalization (ACH)
Rehabilitation Facility (RF)
Skilled Nursing Home (SNH)*
Death
Intensive Care Unit (ICU)
Hospital At Home (HAH)
Psychiatric Ward (PW)
Home
Discharge from ICU = baseline date


All patients
Cluster 1
Cluster 2
Cluster 3
Duration (days)
300
200
100
0
Before
After



Age (years)
18-34
35-44
45-54
55-64
65-69
70-74
75-79
80-84
85-89
>= 90
Sex
Male
Female
Heart failure
Cerebrovascular disease
Diabetes
Active cancer
Chronic respiratory disease
End-stage renal disease
Liver disease
Psychiatric disease
Dementia
Reason for hospitalization
Cardiac surgery
Non-cardiac surgery
Respiratory diseases
Cardiovascular diseases
Poisoning
Neurological diseases (except stroke)
Gastrointestinal diseases
Renal or metabolic diseases
Infectious diseases
Miscellaneous
Length of ICU stay (days)
2-3
4-5
6-10
>10
Noninvasive mechanical ventilation
Fluid resuscitation
Renal replacement therapy
Transcutaneous temporary cardiac stimulation
Administration of blood products
Transcutaneous drainage of a pericardial collection
Cardiopulmonary resuscitation with intubation
Emergency external electrical cardioversion
Mechanical circulatory support
Tracheostomy
Gastrostomy
1
3
10
30
OR
p ≤ 0.05
p > 0.05
Cluster 2
Cluster 3

SUPPLEMENT

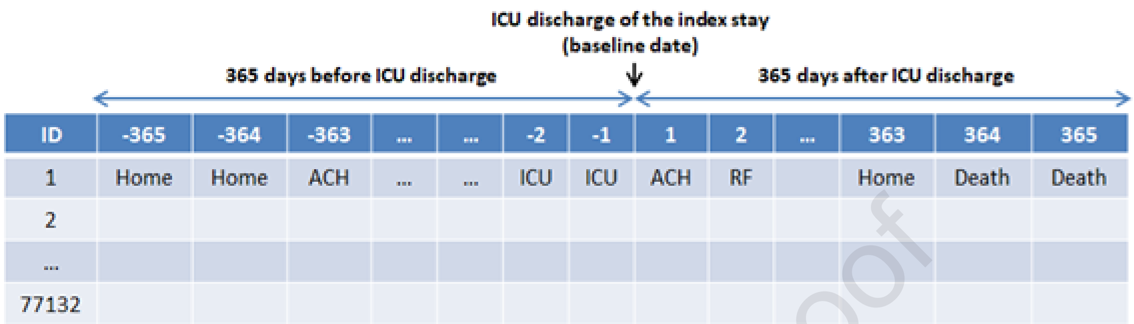
Supplemental Table 1. Description of hospital, SNH and home stays in the year (365 days) before ICU discharge, for all patients and by cluster

*Among patients with at least one stay; ACH: acute care hospital; HAH: hospital at home; ICU: intensive care unit; IQR: interquartile range; LOS: length of stay; PW: psychiatric ward; RF: rehabilitation facilities; SNH: skilled nursing home.

	All patients	Cluster 1	Cluster 2	Cluster 3
Number of patients	77132	52254	13775	11103
ACH				
Index stay (and contiguous stays)				
Number of patients with at least one stay, n (%)	77132 (100)	52 254 (100)	13775 (100)	11103 (100)
Cumulative LOS, days, median (IQR)*	7 (4-15)	6 (4-11)	13 (6-26)	12 (6-23)
Except the index stay (and contiguous stays)				
Number of patients with at least one stay, n (%)	43318 (56·2)	28207 (54·0)	7728 (56·1)	7383 (66·5)
Number of stays, median (IQR)*	1 (1-3)	1 (1-2)	2 (1-3)	2 (1-3)
Cumulative LOS, days, median (IQR)*	7 (3-18)	6 (2-14)	10 (4-25)	16 (7-32)
Of which ICU stays				
Number of patients with at least one stay, n (%)	3754 (4·9)	2104 (4·0)	777 (5·6)	873 (7·9)
Number of stays, median (IQR)*	1 (1-2)	1 (1-2)	1 (1-3)	1 (1-3)
Cumulative LOS, days, median (IQR)*	4 (2-9)	3 (2-7)	5 (2-12)	5 (2-10)
RF				
Number of patients with at least one stay, n (%)	7052 (9·1)	3025 (5·8)	2201 (16·0)	1826 (16·4)
Number of stays, median (IQR)*	1 (1-2)	1 (1-1)	1 (1-2)	1 (1-2)
Cumulative LOS, days, median (IQR)*	31 (18-58)	28 (17-49)	37 (20-72)	31 (16-59)
HAH				
Number of patients with at least one stay, n (%)	1 178 (1·5)	492 (0·9)	286 (2·1)	400 (3·6)
Number of stays, median (IQR)*	1 (1-2)	1 (1-2)	1 (1-3)	1 (1-2)
Cumulative LOS, days, median (IQR)*	29 (12-76)	27 (12-63)	35 (14-100)	30 (11-74)
PW				
Number of patients with at least one stay, n (%)	2916 (3·8)	2174 (4·2)	467 (3·4)	275 (2·5)
Number of stays, median (IQR)*	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-3)
Cumulative LOS, days, median (IQR)*	34 (14-77)	32 (14-72)	36 (15-92)	47 (16-113)
SNH				
Number of patients with at least one stay, n (%)*	1024 (1·3)	542 (1·0)	94 (0·7)	388 (3·5)
Cumulative LOS, days, median (IQR)*	323 (143-351)	335 (166-355)	264 (63-333)	311 (123-348)
Home				
Number of patients with at least one stay, n (%)	76299 (98·9)	51814 (99·2)	13657 (99·1)	10828 (97·5)
Cumulative LOS, days, median (IQR)*	351 (333-358)	354 (343-359)	340 (312-354)	335 (307-351)
Home (including SNH and HAH)				
Number of patients with at least one stay, n (%)	77002 (99·8)	52189 (99·9)	13727 (99·7)	11086 (99·8)
Cumulative LOS, days, median (IQR)*	351 (333-358)	354 (343-359)	340 (312-354)	336 (309-351)

Supplemental Figure 1. Graphic representation of the methodology used to report stays before and after ICU discharge

In example in line 1, one state was determined for each day; 365 days before and 365 days after baseline date with 8 possible states: **Death**; **ICU**: intensive care unit; **ACH**: acute care hospital; **PW**: psychiatric ward; **RF**: rehabilitation facility; **HAH**: hospital at home; **SNH**: skilled nursing home; **Home.**



ID	-365	-364	-363	...	...	-2	-1	1	2	...	363	364	365
1	Home	Home	ACH	...	...	ICU	ICU	ACH	RF		Home	Death	Death
2													
...													
77132													

- Descriptive statistics

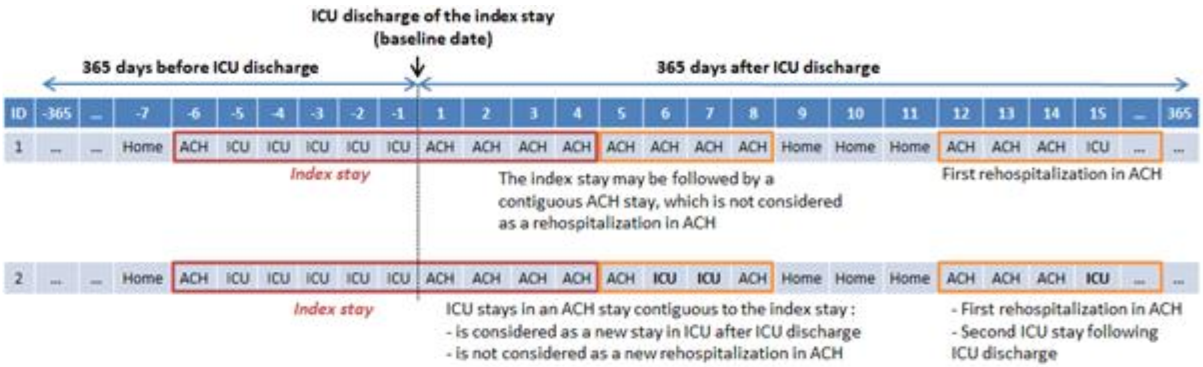
From these individual daily sequences, for the year before and the year after ICU discharge, we determine:

- Baseline date: the ICU discharge date of the index stay was the baseline date for each individual sequence. As patients may have been immediately transferred to other ICU units (n = 1197), we considered in such cases the baseline date as the discharge date from the final ICU stay continuously following the index stay

- the number of patients who spent at least one day in each state: **Number of patients with at least one stay, n (%)**
- the number of stays in each state (at each transition between two states, the stay is considered to be over; if two stays follow one another but the patient remains in the same 'state' (for example, transfer to another hospital), only one stay is counted): **Number of stays, median (IQR)**
- the total number of days in each state (regardless of the number of stays): **Cumulative length of stay (LOS), days, median (IQR)**

- Hospitalisations in ACH in the year before or after ICU discharge (see figure below) :
- They include all ACH stays except the index stay and possible contiguous stays (transfers from ACH to ACH)
- To calculate the number of stays and the cumulative length of stay in ACH, the days in ICU are considered as days in ACH (ICU duration is included in ACH duration)

Journal Pre-proof


ICU discharge of the index stay
(baseline date)
365 days before ICU discharge
365 days after ICU discharge
Index stay
The index stay may be followed by a contiguous ACH stay, which is not considered as a rehospitalization in ACH
First rehospitalization in ACH
Index stay
ICU stays in an ACH stay contiguous to the index stay :
- is considered as a new stay in ICU after ICU discharge
- is not considered as a new rehospitalization in ACH
- First rehospitalization in ACH
- Second ICU stay following ICU discharge

Supplemental Figure 2. Flow chart of the study population selection