Supplementary data. The differences between the countries' data sources the procedure codes.

Austria

Hospital discharge statistics in Austria encompass all inpatient stays, including both full inpatient stays (with at least one overnight stay) and day cases (zero-night stays where admission and discharge occur on the same day). These statistics document patient, hospital, and medical characteristics for each hospital stay with a discharge date within the reference year. The legal framework for these statistics is the Federal Act on Documentation in Health Care (Federal Law Gazette No. 745/1996), which mandates that hospitals record administrative and medical data on patients and that Statistics Austria publish key figures. The data, derived from Austrian hospitals' diagnosis and performance reports, are compiled under the performance-based hospital financing system (DRG system, based on diagnosis-related groups of medical procedures) (1). This system ensures comprehensive documentation of inpatient care in Austria, enabling detailed analysis of healthcare utilization and outcomes. Incidence rates were calculated using Austrian mid-year population figures, obtained from Statistik Austria (2).

England

HES-APC records all admitted patient care episodes in England funded by the NHS, as well as privately funded care in NHS hospitals, providing near universal coverage of NHS care (3). The dataset included information on patient age, primary and secondary diagnoses, as well as surgical procedures performed during hospital inpatient stays and day cases. Procedure codes were used to define fracture management categories: intramedullary; extramedullary; internal (unspecified); external; and no surgical fixation; intramedullary, extramedullary, and internal (unspecified) were combined into a single 'internal surgery' category. If more than one surgical fixation occurred within an admission, the first

recorded fixation was used to categorise; the exception to this was if someone had an external fixator followed by an internal fixation, then the first internal fixation was used to categorise. With the data from England, we replicated the previous analysis by Scott et al. (4). Hospital Episode Statistics were re-used with the permission of the Health and Social Care Information Centre ("NHS Digital"); All rights reserved. Incidence rates were calculated using mid-year (June) population estimates for each corresponding year, obtained from the Office for National Statistics (5).

Finland

All HES records are included in the Finnish National Hospital Discharge Register (NHDR). The dataset included information on patient age, primary and secondary diagnoses, as well as surgical procedures performed during hospital stay. The NHDR has been demonstrated to have high external validity in terms of both coverage and procedural coding accuracy (6). We used the NOMESCO procedure code NHJ10 to identify patients who underwent surgical intervention (Table 1). Population data for Finland during the study years were obtained from Statistics Finland database (7). Only the first surgical procedure per patient within each treatment period was included in the study. Incidence rates were calculated using mid-year population estimates for each corresponding year, obtained from the Official Statistics Finland (7)

Germany

In Germany, all in-hospital medical procedures must be reported to the German Federal Statistical Office for reimbursement (8). As a result, every German hospital contributes to a national registry, ensuring comprehensive coverage and highly accurate procedural coding. The data, transmitted anonymously and coded using the German Procedure Classification System (OPS), form the basis for the official annual national

healthcare report. Datasets covering the years 2013–2022, categorized by 5-year age increments and gender (male, female), were analyzed for this study. To identify all lateral malleolar surgeries in adults (≥ 20 years), the datasets were screened for specific OPS codes (Appendix 3). Incidence rates were calculated using the German mid-year population figures, obtained from the German Federal Statistical Office (9).

Sweden

The Swedish National Patient Register (SNPR) was established in 1964-1965 by the Swedish National board of Health and Welfare. It has nationwide coverage and high validity (10). It contains documentation of all individual hospital discharges, each record corresponding to one "hospital-episode". SNPR provides demographic and treatment-related data (age, sex, date of admission and discharge, primary and secondary diagnoses, and codes for surgery, injury and external cause, and other interventions. Every record contains a national registration number, a unique identifier assigned to all Swedish residents. All diagnoses are coded according to the Swedish version of the International Classification of Diseases (ICD-10). We used the Classification of Surgical Procedures (Socialstyrelsen) procedure codes NHJ60 and NHJ69 to identify patients who underwent surgical intervention (Table 1). Only the first surgical procedure per patient within each treatment period was included in the study. Approval was obtained from the Regional and National Ethical Authorities. Incidence rates were calculated using the Swedish mid-year population figures, obtained from Statistics Sweden (11).

Sweden has also second high quality national register, Swedish Fracture Register (SFR), which has full national coverage on fractures (12). As our study focused on the incidence of surgical procedures, not fracture incidence, we chose to use the SNPR, which reliably captures all inpatient surgical episodes and thus is more suitable for this purpose.

Switzerland

The Medical Statistics of Hospitals database, maintained by the Swiss Federal Statistical Office (FSO), systematically compiles data on all inpatient care episodes in Switzerland. It provides case-level information on patient demographics (age, sex), primary and secondary diagnoses (coded using the ICD-10-GM classification) (13), and surgical procedures (classified under the Swiss Classification of Surgical Interventions [CHOP]) (14). The database is available upon request from the FSO (14). For this study, patients who underwent surgical management for ankle fractures were identified using relevant CHOP procedure codes (see Table 1). The Medical Statistics of Hospitals database has been widely used in healthcare research, including studies on surgical site infections and treatment outcomes, demonstrating its utility for epidemiological analysis. Annual incidence was calculated using Swiss mid-year population, obtained from the Swiss Federal Statistical Office (15).

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Supplementary Table 1. Incidence rate ratios (IRR) with 95% confidence interval (CI) of internal fixations due to lateral malleolar fractures over time, categorised by age group and country. IRRs were calculated using the mean incidence from 2013 to 2015 as a reference

Year	Age	Austria		England		Finland		Germany		Sweden		Switzerland	
		IRR (CI)	%	IRR (CI)	%	IRR (CI)	%	IRR (CI)	%	IRR (CI)	%	IRR (CI)	%
	All												
2013		1.04 (0.98–1.11)	4	0.99 (0.94–1.04)	–1	1.10 (1.01–1.20)	10	1.08 (1.06–1.09)	8	1.16 (1.06–1.27)	16	1.05 (0.99–1.11)	5
2014		0.95 (0.89–1.01)	–5	1.04 (1.00–1.09)	4	0.96 (0.87–1.05)	–4	0.94 (0.92–0.96)	–6	0.89 (0.81–0.98)	–11	0.96 (0.91–1.01)	–4
2015		1.01 (0.95–1.07)	1	0.97 (0.92–1.02)	–3	0.95 (0.86–1.03)	–5	0.98 (0.97–1.00)	–2	0.95 (0.87–1.05)	–5	0.99 (0.94–1.05)	–1
2016		1.00 (0.94–1.06)	0	0.93 (0.89–0.98)	–7	0.97 (0.88–1.06)	–3	0.99 (0.97–1.00)	–1	0.91 (0.83–1.00)	–9	0.90 (0.85–0.95)	–10
2017		1.00 (0.94–1.06)	0	0.94 (0.90–0.99)	–6	1.08 (0.99–1.18)	8	1.03 (1.02–1.05)	3	0.90 (0.82–0.99)	–10	0.95 (0.90–1.00)	–5
2018		0.97 (0.91–1.03)	–3	0.80 (0.76–0.84)	–20	0.87 (0.79–0.95)	–13	0.96 (0.95–0.98)	–4	0.86 (0.78–0.94)	–14	0.93 (0.88–0.98)	–7
2019		0.98 (0.92–1.04)	–2	0.78 (0.74–0.82)	–22	0.93 (0.85–1.02)	–7	0.97 (0.95–0.98)	–3	0.82 (0.75–0.91)	–18	0.87 (0.82–0.92)	–13
2020		0.88 (0.82–0.93)	–12	0.58 (0.55–0.62)	–42	0.72 (0.65–0.79)	–28	0.83 (0.81–0.84)	–17	0.68 (0.61–0.75)	–32	0.73 (0.69–0.78)	–27
2021		0.96 (0.90–1.02)	–4	0.80 (0.77–0.85)	–20	0.74 (0.68–0.82)	–26	1.00 (0.99–1.02)	0	0.71 (0.64–0.79)	–29	0.86 (0.82–0.91)	–14
2022		0.96 (0.90–1.02)	–4	0.72 (0.68–0.75)	–28	0.74 (0.68–0.82)	–26	0.99 (0.97–1.00)	–1	–	–	0.75 (0.71–0.80)	–25
	<60												
2013		1.04 (0.96–1.12)	4	0.98 (0.93–1.03)	–2	1.12 (1.01–1.24)	12	1.07 (1.05–1.09)	7	1.16 (1.04–1.30)	16	1.04 (0.97–1.11)	4
2014		0.96 (0.89–1.04)	–4	1.04 (0.98–1.09)	4	0.94 (0.84–1.05)	–6	0.94 (0.92–0.96)	–6	0.88 (0.78–0.99)	–12	0.97 (0.90–1.03)	–3
2015		1.00 (0.93–1.08)	0	0.98 (0.93–1.03)	–2	0.94 (0.84–1.05)	–6	0.99 (0.96–1.01)	–1	0.96 (0.85–1.08)	–4	0.99 (0.93–1.06)	–1
2016		1.02 (0.95–1.10)	2	0.92 (0.87–0.97)	–8	0.98 (0.88–1.09)	–2	1.00 (0.98–1.02)	0	0.90 (0.80–1.02)	–10	0.92 (0.86–0.99)	–8
2017		1.02 (0.94–1.09)	2	0.94 (0.89–0.99)	–6	1.08 (0.97–1.20)	8	1.04 (1.02–1.07)	4	0.91 (0.81–1.03)	–9	0.97 (0.91–1.04)	–3
2018		1.01 (0.93–1.09)	1	0.80 (0.76–0.85)	–20	0.89 (0.80–0.99)	–11	0.97 (0.95–0.99)	–3	0.81 (0.71–0.91)	–19	0.95 (0.89–1.02)	–5
2019		1.00 (0.92–1.08)	0	0.78 (0.74–0.83)	–22	0.94 (0.84–1.05)	–6	0.98 (0.96–1.01)	–2	0.85 (0.75–0.96)	–15	0.89 (0.83–0.95)	–11
2020		0.87 (0.81–0.94)	–13	0.57 (0.54–0.61)	–43	0.70 (0.63–0.79)	–30	0.83 (0.81–0.85)	–17	0.68 (0.60–0.78)	–32	0.76 (0.71–0.81)	–24
2021		0.97 (0.90–1.05)	–3	0.80 (0.76–0.85)	–20	0.72 (0.64–0.81)	–28	1.03 (1.01–1.05)	3	0.71 (0.63–0.81)	–29	0.91 (0.85–0.97)	–9
2022		0.98 (0.91–1.06)	–2	0.72 (0.68–0.77)	–28	0.73 (0.65–0.82)	–27	1.01 (0.99–1.03)	1	–	–	0.80 (0.75–0.86)	–20
	≥60												

2013	1.06 (0.95–1.19)	6	1.02 (0.92–1.13)	2	1.02 (0.87–1.20)	2	1.09 (1.06–1.12)	9	1.16 (1.00–1.35)	16	1.08 (0.98–1.18)	8
2014	0.92 (0.82–1.04)	–8	1.06 (0.96–1.18)	6	1.01 (0.86–1.19)	1	0.93 (0.90–0.95)	–7	0.90 (0.77–1.05)	–10	0.95 (0.86–1.04)	–5
2015	1.01 (0.91–1.13)	1	0.91 (0.82–1.01)	–9	0.96 (0.82–1.14)	–4	0.98 (0.96–1.01)	–2	0.94 (0.81–1.10)	–6	0.98 (0.89–1.08)	–2
2016	0.94 (0.83–1.05)	–6	1.00 (0.91–1.11)	0	0.93 (0.79–1.10)	–7	0.97 (0.94–0.99)	–3	0.92 (0.78–1.07)	–8	0.83 (0.75–0.92)	–17
2017	0.94 (0.84–1.05)	–6	0.95 (0.86–1.05)	–5	1.07 (0.91–1.25)	7	1.01 (0.99–1.04)	1	0.88 (0.75–1.03)	–12	0.88 (0.80–0.98)	–12
2018	0.86 (0.76–0.96)	–14	0.78 (0.70–0.87)	–22	0.79 (0.67–0.94)	–21	0.95 (0.92–0.97)	–5	0.98 (0.84–1.14)	–2	0.86 (0.78–0.95)	–14
2019	0.93 (0.83–1.05)	–7	0.79 (0.71–0.88)	–21	0.89 (0.75–1.05)	–11	0.92 (0.89–0.95)	–8	0.75 (0.64–0.88)	–25	0.80 (0.73–0.89)	–20
2020	0.88 (0.79–0.99)	–12	0.64 (0.57–0.71)	–36	0.76 (0.64–0.91)	–24	0.82 (0.79–0.84)	–18	0.67 (0.56–0.79)	–33	0.67 (0.60–0.74)	–33
2021	0.93 (0.84–1.04)	–7	0.82 (0.74–0.91)	–18	0.84 (0.71–0.99)	–16	0.94 (0.91–0.97)	–6	0.70 (0.60–0.83)	–30	0.74 (0.67–0.82)	–26
2022	0.90 (0.80–1.01)	–10	0.69 (0.62–0.77)	–31	0.87 (0.74–1.03)	–13	0.93 (0.90–0.95)	–7	–	–	0.63 (0.57–0.70)	–37

Supplementary Table 2. Included procedure codes in Germany, England and Switzerland.

Germany
5-790.3r Closed Reduction - Reamed intramedullary Nail
5-790.4r Closed Reduction - Locked intramedullary Nail
5-790.5r Closed Reduction - Intramedullary Nail with joint components

5-793.3r Open Reduction - Simple Fracture – Conventional Plate
5-793.ar Open Reduction - Simple Fracture – Intramedullary Nail with joint component
5-793.br Open Reduction - Simple Fracture – Intramedullary Nail
5-793.cr Open Reduction - Simple Fracture – Intramedullary Nail with Transfixation
5-793.kr Open Reduction - Simple Fracture – Angular Stable Locking Plate

5-794.2 Open Reduction – Multifragmentary Fracture – Conventional Plate
5-794.ar Open Reduction - Multifragmentary Fracture – Intramedullary Nail with joint component
5-794.br Open Reduction - Multifragmentary Fracture – Intramedullary Nail
5-794.cr Open Reduction - Multifragmentary Fracture – Intramedullary Nail with Transfixation
5-794.kr Open Reduction - Multifragmentary Fracture – Angular Stable Locking Plate

England

Intramedullary fixation will be identified using the following *procedure* codes:

W192	Primary open reduction of fracture of long bone and fixation using rigid nail NEC
W193	Primary open reduction of fracture of long bone and fixation using flexible nail
W194	Primary open reduction of fracture of small bone and fixation using screw
W195	Primary open reduction of fragment of bone and fixation using screw
W196	Primary open reduction of fragment of bone and fixation using wire system
W198	Other specified primary open reduction of fracture of bone and intramedullary fixation
W199	Unspecified primary open reduction of fracture of bone and intramedullary fixation
W244	Closed reduction of fracture of small bone and fixation using screw
W245	Closed reduction of fragment of bone and fixation using screw
W231	Secondary open reduction of fracture of bone and intramedullary fixation HFQ

Extramedullary fixation will be identified using the following *procedure* codes:

W201	Primary open reduction of fracture of long bone and extramedullary fixation using plate NEC
W202	Primary open reduction of fracture of long bone and extramedullary fixation using cerclage
W203	Primary open reduction of fracture of long bone and extramedullary fixation using suture
W204	Primary open reduction of fracture of long bone and complex extramedullary fixation NEC
W205	Primary open reduction of fracture of ankle and extramedullary fixation NEC
W208	Other specified primary open reduction of fracture of bone and extramedullary fixation
W209	Unspecified primary open reduction of fracture of bone and extramedullary fixation
W654	Primary open reduction of fracture dislocation of joint and internal fixation NEC
W232	Secondary open reduction of fracture of bone and extramedullary fixation HFQ
W677	Secondary open reduction of fracture dislocation of joint and internal fixation

Internal fixation (location unspecified) were identified using the following *procedure* codes:

W211	Primary reduction of intra-articular fracture of bone using arthrotomy as approach
W213	Primary fixation of fragment of chondral cartilage of intra-articular fracture of bone
W214	Primary intra-articular fixation of intra-articular fracture of bone NEC
W215	Primary extra-articular reduction of intra-articular fracture of bone
W218	Other specified primary open reduction of intra-articular fracture of bone
W219	Unspecified primary open reduction of intra-articular fracture of bone

W242	Closed reduction of fracture of long bone and rigid internal fixation NEC
W243	Closed reduction of fracture of long bone and flexible internal fixation HFQ
W246	Closed reduction of fracture of bone and fixation using nail or screw
W248	Other specified closed reduction of fracture of bone and internal fixation
W249	Unspecified closed reduction of fracture of bone and internal fixation
W281	Application of internal fixation to bone NEC
W288	Other specified other internal fixation of bone
W289	Unspecified other internal fixation of bone
W236	Secondary open reduction of fracture of bone and internal fixation HFQ
W282	Adjustment to internal fixation of bone NEC
W283	Removal of internal fixation from bone NEC

Switzerland

79.36.60 Open reduction of a simple fibular shaft fracture with internal bone fixation using an intramedullary nail
79.36.61 Open reduction of a simple fibular shaft fracture with other internal bone fixation
79.36.62 Open reduction of a multifragmentary fracture of the fibular shaft with internal bone fixation using an (angular stable) plate
79.36.63 Open reduction of a multifragmentary fracture of the fibular shaft with other internal bone fixation
79.36.70 Open reduction of a simple fracture of the distal fibula with internal bone fixation using (Blount) clamps
79.36.71 Open reduction of a simple fracture of the distal fibula with internal bone fixation using a plate
79.36.72 Open reduction of a simple fracture of the distal fibula with other internal bone fixation
79.36.73 Open reduction of a multifragmentary fracture of the distal fibula with internal bone fixation