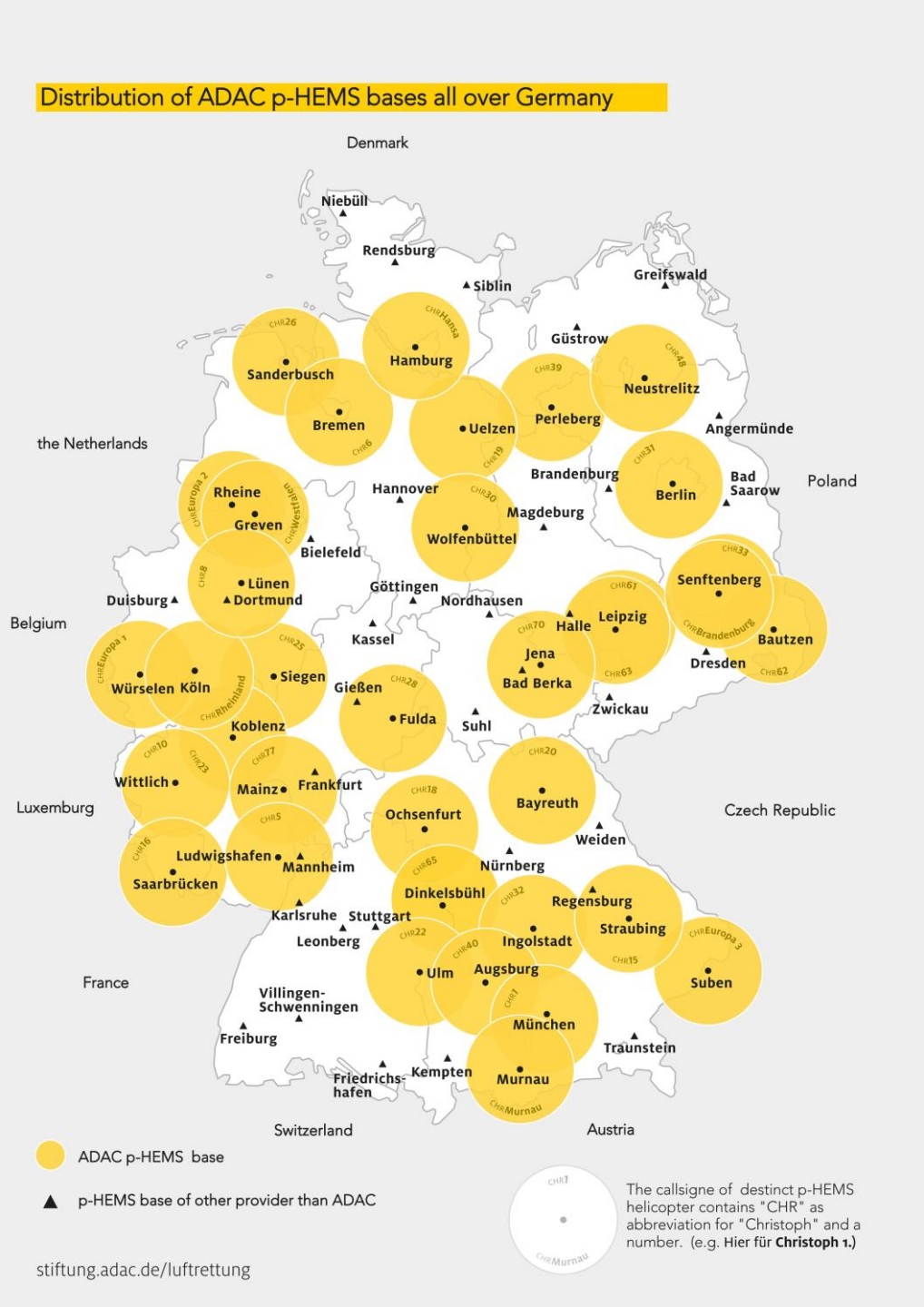
Electronic Supplement

Supplemental Figure 1: All the General German Automobile Club (ADAC) helicopter bases



Supplemental Table 1: All the General German Automobile Club (ADAC) helicopter bases from 2005 to 2017.

Call Sign	Location	05	06	07	08	09	10	11	12	13	14	15	16	17
Christoph. 01	Munich	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes	Yes
Christoph 05	Ludwigshafen	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes	Yes
Christoph 06	Bremen	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes	Yes
Christoph 08	Lünene	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes	Yes
Christoph 10	Wittlich	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 15	Straubing	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 16	Saarbrücken	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 18	Ochsenfurt	no	no	no	no	no	no	yes	yes	yes	yes	yes	yes	yes
Christoph 19	Uelzen	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 20	Bayreuth	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 22	Ulm	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 23	Koblenz	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 25	Siegen	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 26	Sanderbusch	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 28	Fulda	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 30	Wolfenbüttel	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 31	Berlin	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 32	Ingolstadt	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 33	Senftenberg	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 39	Perleberg	no	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 40	Augsburg	no	no	no	no	no	no	no	no	no	yes	yes	yes	yes
Christoph 48	Neustrelitz	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 50	Hamburg	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 61	Leipzig	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 62	Bautzen	no	no	no	no	no	no	no	yes	yes	yes	yes	yes	yes
Christoph 63	Leizig	yes, as Chr. 72	yes, as Chr. 72	yes, as Chr. 72	yes, as Chr. 72	yes, as Chr. 72	yes, as Chr. 72	yes, as Chr. 72	yes, from May as Chr. 63	yes	yes	yes	yes	yes
Christoph 65	Dinkelsbühl	no	no	no	no	no	no	no	no	no	no	yes	yes	yes
Christoph 70	Jena	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph 77	Mainz	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes
Christoph Brandenburg	Senftenberg	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph Europa 1	Würselen	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph Europa 2	Rheine	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph Murnau	Murnau	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph Rhein-Land	Cologne	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Christoph Westfalen	Münster-Osnabrück	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	Yes

Supplemental Table 2: Missing data for all crude variables are shown as absolute values and percentages for the master dataset, as well as for the analyzed subgroups. Based on the values of these crude variables, several classifications of vital signs are coded (or assigned) during statistical analysis. For example, if a patient's crude variable for SBP is 185mmHg, the coded variable would be for "arterial hypertension" positive. Therefore, in the absence of a crude variable, a coded variable cannot be calculated. The mean dataset completeness of all 23 variables is 3.6% (87,398/2,454,790). Complete information is available for 81.2% (86,632/106,730) cases of the study dataset.

	Table 1	**Table 2 and 3**
	study dataset n=106,730	**sufficient pain therapy n=87,114**
Demographics		
patient age	0 (.0%)	0 (.0%)
male patients	7 (.0%)	5 (.0%)
year of treatment	0 (.0%)	0 (.0%)
On scene		
RR	14,573 (13.7%)	10,263 (11.8%)
ECG rhythm	4,772 (4.5%)	3,881 (4.5%)
HR	1,950 (1.8%)	1,019 (1.2%)
SBP	4,734 (4.4%)	3,188 (3.7%)
SpO_2	3,133 (2.9%)	1,784 (2.1%)
GCS	0 (.0%)	0 (.0%)
NRS	0 (.0%)	0 (.0%)
NACA Score	0 (.0%)	0 (.0%)
Out-of-hospital pain treatment		
pharmacological pain treatment	0 (.0%)	0 (.0%)
nonpharmacological measures	29 (.0%)	14 (.0%)
Mission characteristics		
year of mission	0 (.0%)	0 (.0%)
type of transport	2,015 (1.9%)	1,366 (1.6%)
Coded presenting complaint	**34 (.0%)**	**26 (.0%)**
Handover		

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	Table 1	**Table 2 and 3**
	study dataset n=106,730	**sufficient pain therapy n=87,114**
RR	14,981 (14.0%)	10,597 (12.2%)
HR	2,662 (2.5%)	1,660 (1.9%)
ECG	4,621 (4.3%)	3,766 (4.3%)
SBP	6,255 (5.9%)	4,530 (5.2%)
SpO_2	3,377 (3.2%)	2,014 (2.3%)
GCS	6 (.0%)	6 (.0%)
NRS	0 (.0%)	0 (.0%)

Missing data for the subgroup of patients with oligoanalgesia can be calculated by subtracting the figures of column 2 (sufficient pain therapy) from those in column 1 (study dataset). (Abbreviations: ECG = electrocardiogramm; GCS = Glasgow Coma Scale; HR = heart rate; NACA = National Advisory Committee for Aeronautics; NRS = numeric rating scale; RR = respiratory rate; SBP = systolic blood pressure; SpO_2 = oxygen saturation)

Supplemental Table 3: Descriptive statistics of patients handed over on-scene to another EMS provider, patients transported via ground accompanied by the HEMS physician, and patients transported by the p-HEMS team via air.

	Handover on-scene to another EMS provider (n = 22,585, 21.6%)	Ground transport with p-HEMS physician (n = 33,616, 32.1%)	Air transport with p-HEMS team (n = 48,514, 46.3%)
Demographics			
patient age (y)	55 ± 24	58 ± 22	44 ± 22
male patients	52.1%	59.2%	69.0%
On scene			
RR (min^{-1})	16 ± 4	16 ± 5	16 ± 5
bradypnea (RR ≤ 7 min^{-1})	.1%	.1%	.1%
tachypnea (RR ≥ 31 min^{-1})	.7%	1.1%	.8%
HR [min^{-1}]	88 ± 18	91 ± 24	92 ± 21
bradycardia (HR ≤ 44 min^{-1})	.4%	1.1%	.5%
tachycardia (HR ≥ 121 min^{-1})	3.8%	8.0%	6.6%
SBP (mmHg)	144 ± 30	144 ± 34	136 ± 28
arterial hypotension (SBP ≤ 79 mmHg)	.5%	1.7%	1.3%
arterial hypertension (SBP ≥ 181 mmHg)	9.1%	11.1%	4.6%
SpO_2 (%)	97 ± 5	96 ± 6	96 ± 6
hypoxia (SpO_2 ≤ 89%)	2.1%	5.6%	4.9%
GCS (3–15)	14.9 ± .4	14.8 ± .7	14.7 ± 1.0
GCS ≤ 12	.7%	2.0%	4.6%
NRS (0–10)	6.2 ± 1.8	6.3 ± 1.8	6.3 ± 1.8
severe pain	26.2%	29.4%	28.1%
NACA Score: I	.1%	.0%	.0%
NACA Score: II	7.5%	1.4%	.9%
NACA Score: III	66.1%	35.8%	34.8%
NACA Score: IV	24.9%	47.9%	46.8%
NACA Score: V	1.4%	14.8%	17.4%
Out-of-hospital pain treatment			
any type of pain therapy	71.5%	79.7%	91.3%
pharmacological pain treatment	68.1%	77.0%	86.5%
nonpharmacological pain treatment	24.2%	25.1%	55.2%
pharmacological and nonpharmacological pain treatment	20.9%	22.4%	50.4%

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	Handover on-scene to another EMS provider (n = 22,585, 21.6%)	Ground transport with p-HEMS physician (n = 33,616, 32.1%)	Air transport with p-HEMS team (n = 48,514, 46.3%)
any opioid	55.5%	65.3%	74.5%
strong opioids	29.3%	24.1%	50.3%
moderate opioids	25.8%	41.1%	25.7%
weak opioids	.2%	.2%	.2%
Ketamine	9.3%	13.4%	20.9%
non-opioid analgesics	9.1%	7.7%	2.4%
Coded major complaint			
central nervous system disorder	3.7%	3.2%	3.2%
cardio-vascular disorder	14.6%	42.3%	10.0%
pulmonary and thoracic illness	2.9%	2.0%	.3%
abdominal illness	13.5%	7.4%	2.0%
psychiatric illness	.6%	.3%	.1%
metabolic disorders	.4%	.6%	.1%
gynecology/obstetric disorder	.4%	.6%	.2%
other	9.4%	2.8%	1.5%
trauma (incl. TBI)	54.5%	41.0%	82.6%
Handover			
RR (min^{-1})	14 ± 4	14 ± 4	14 ± 4
HR (min^{-1})	85 ± 16	84 ± 19	85 ± 18
SBP (mmHg)	138 ± 28	134 ± 23	131 ± 22
SpO_2 (%)	97 ± 5	97 ± 5	98 ± 5
GCS (3–15)	14.8 ± 1.0	14.5 ± 1.9	13.1 ± 4.0
NRS (0–10)	2.7 ± 2.1	2.2 ± 2.0	2.0 ± 2.0
ΔNRS (Points)	3.5 ± 2.6	4.1 ± 2.5	4.3 ± 2.7
ΔNRS≥3 (%)	64.8%	76.1%	75.4%
Oligoanalgesia (%)	25.7%	15.6%	16.3%

Data are shown as percentages or mean value with standard deviation (SD). Figures of measured vital signs are rounded towards the nearest integer due to their assumed measuring accuracy (Abbreviations: ΔNRS = pain reduction; ECG = electrocardiogram; EMS = emergency medical service; GCS = Glasgow

Coma Scale; HR = heart rate; min^{-1} = $minute^{-1}$; mmHg = millimeter mercury; NACA= National Advisory Committee for Aeronautics score; NRS = numeric rating scale; p-HEMS = physician-staffed helicopter emergency medical service; RR = respiratory rate; SBP = systolic blood pressure; SpO_2 = oxygen saturation; TBI = traumatic brain injury; y = year)

Supplemental Text Document 1

Characteristics of patient subgroups of special interest

Patients with severe pain on the scene

In total, 29,883 patients (28.0%) had severe on-scene pain (NRS ≥ 8). Patients with severe pain had an NRS of 8.6 ± 0.81 (median 8, IQR 1). Patients in the moderate-pain subgroup had an NRS of 5.4 ± 1.1 (median 5, IQR 2). The ΔNRS achieved was higher in the severe-pain subgroup (6.1 ± 2.7, median 6, IQR 3) than in the moderate-pain subgroup (3.2 ± 2.1, median 3, IQR 3) (p-value < 0.001). Thus, 26,438 (88.5%) of the patients with severe pain received sufficient pain therapy, and 79.0% of patients in the moderate-pain group received sufficient pain therapy (OR for sufficient pain therapy: 2.05 [95% CI, 1.97–2.13] with pain rated as severe on-scene). Despite an NRS ≥ 8, no pain therapy was initiated in 7.2% of these patients, as compared to 20.9% in the moderate-pain subgroup.

Trauma as a major complaint

The trauma cohort constituted 62.8% of the study dataset (n = 67,025) and mostly comprised male patients (65.0%; n = 43,555). Pharmacological pain therapy was used in 87.1% (n = 58,392) of all trauma patients, while non-pharmacological measures, such as splinting or immobilization, were used in 59.5% (n = 39,874). Both types were used in 36,041 patients (53.8%). This represents the highest incidence of pain therapy among all major complaint subgroups in this sample. In 51.6% of all trauma patients, strong opioids were used. In 24.3%, ketamine was mainly used.

Cardiovascular issues as a major complaint

The cardiovascular cohort constituted 21.4% of the whole dataset (n = 22,782). Patient age was the highest (67 ± 15 years) among the major complaint subgroups in this sample. NRS on the scene was 5.8 ± 1.6 (median 5, IQR 3). Of these patients, 68.4% (n = 15,589) received pharmacological pain therapy on the scene, which was the second-highest proportion after trauma (87.8%): In total, 14,746 patients received some type of opioid (64.8%), while only 1,026 patients (4.5%) received strong opioids. Moderate opioids were used for 13,811 patients (60.6%), and weak opioids were used for 32 patients (0.01%). Non-opioid pain therapy was used for 10.4% of all patients with cardiovascular complaints. Treatment resulted in a mean pain reduction of 3.6 ± 2.2 NRS points (median 4, IQR 3) and resulted in sufficient analgesia in 19,014 (83.5%) of all patients with cardiovascular complaints. Thus, this subgroup had the highest frequency in this sample of sufficient pain therapy, followed by trauma (82.2% of all trauma cases).