International Journal of Cardiology 148 (2011) 300–304

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Acute coronary syndromes in young patients: Presentation, treatment and outcome

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ARTICLE INFO

Article history:
Received 9 July 2009
Received in revised form 26 October 2009
Accepted 15 November 2009
Available online 26 November 2009

Keywords:
Cohort studies
Myocardial ischemia
Coronary angiography

ABSTRACT

Background: Acute coronary syndromes (ACS) in very young patients have been poorly described. We therefore evaluate ACS in patients aged 35 years and younger.
Methods: In this prospective cohort study, 76 hospitals treating ACS in Switzerland enrolled 28,778 patients with ACS between January 1, 1997, and October 1, 2008. ACS definition included ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina (UA).
Results: 195 patients (0.7%) were 35 years old or younger. Compared to patients >35 years, these patients were more likely to present with chest pain (91.6% vs. 83.7%; $P=0.003$) and less likely to have heart failure (Killip class II to IV in 5.2% vs. 23.0%; $P<0.001$). STEMI was more prevalent in younger than in older patients (73.1% vs. 58.3%; $P<0.001$). Smoking, family history of CAD, and/or dyslipidemia were important cardiovascular risk factors in young patients (prevalence 77.2%, 55.0%, and 44.0%). The prevalence of overweight among young patients with ACS was high (57.8%). Cocaine abuse was associated with ACS in some young patients. Compared to older patients, young patients were more likely to receive early percutaneous coronary interventions and had better outcome with fewer major adverse cardiac events.
Conclusions: Young patients with ACS differed from older patients in that the younger often presented with STEMI, received early aggressive treatment, and had favourable outcomes. Primary prevention of smoking, dyslipidemia and overweight should be more aggressively promoted in adolescence.

1. Introduction

According to its higher prevalence in middle-aged and elderly patients, comparatively few studies have focused on the clinical presentation, treatment and outcome of acute coronary syndromes (ACS) in young patients [1–12]. In most of these studies, the definition of young included patients older than 35 years [2,3,5–12]. Many of these studies reported on few patients [4–8], were confined to patients with myocardial infarction [1–6,9–12], or were otherwise restricted to specific patient populations [3,5,7–9]. Though patients aged 35 years or less account for only a minor proportion of all patients with ACS, the young patient is of particular interest considering the years of potential life lost. We therefore evaluate the clinical presentation, treatment and outcome of patients aged 35 years and younger who were admitted with an ACS to one of 76 hospitals in Switzerland.

2. Materials and methods

2.1. Patients

The AMIS (Acute Myocardial Infarction in Switzerland) Plus project is a prospective cohort study of patients admitted with ACS to various type of hospitals in Switzerland [13–18]. For inclusion in the cohort, patients had to conform to one of the following final diagnosis: ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), or unstable angina (UA). Definition of STEMI required ST-segment elevation or new left bundle branch block on initial electrocardiogram (ECG), and elevated cardiac markers (either total creatine kinase (CK) or CK-MB at least twice the upper limit of the normal range, or troponin I or T above individual hospital cut-off for myocardial infarction). NSTEMI was diagnosed in the presence of symptoms or ECG changes compatible with ACS, or both, and elevated cardiac markers, but criteria for STEMI were not fulfilled. Diagnosis of UA required symptoms or ECG changes compatible with ACS, or both, and normal cardiac markers. The study population comprised all

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doi:10.1016/j.ijcard.2009.11.009

patients enrolled in the AMIS Plus cohort study between January 1, 1997, and October 1, 2008. The cohort study was approved by all local Cantonal Ethic Commissions, the Above-Regional Ethics Committee for Clinical Studies, and the Swiss Board for Data Security.

2.2. Data collection

76 hospitals treating ACS in Switzerland, ranging from community institutions to large tertiary facilities, were enrolling patients. All participating hospitals had either a facility to perform percutaneous coronary interventions (PCI) or a contract with a nearby hospital guaranteeing PCI access within a maximum of 1.5 h for all patients. Participating centres provided anonymized data for each patient through a standardised internet or paper based questionnaire. The standardised questionnaire comprised 160 items for each patient and was filled in by the coordinator of each institution. It seeks information regarding previous medical history, clinical presentation at hospital admission, in-hospital management, and in-hospital prognosis. Cardiovascular risk factors were defined as follows: dyslipidemia, hypertension and/or diabetes was considered present, if the patient was treated for dyslipidemia, hypertension and/or diabetes or if it was previously diagnosed by a primary care physician according to guidelines [19,20]. A family history of coronary artery disease (CAD) was considered present, if a first-degree relative younger than 60 years had CAD; overweight was defined as body mass index (BMI) >25 kg/m^2.

All data were centralised at the Institute of Social and Preventive Medicine at the University of Zurich, where data were checked for plausibility and consistency and incomplete questionnaires were returned to the enrollment centres for completion. In 2003, 19% of questionnaires were returned to the enrollment centre for completion, in most cases due to 1 implausible or incomplete variable. In December 2004, an independent physician reviewed hospital case records on a random sample of 20 patients for internal validation, which demonstrated good agreement with data obtained from questionnaires (κ scores >0.8 for baseline data and therapeutic interventions). Error rate was 0% for therapeutic interventions, 0%–0.9% for baseline characteristics, and 1.2% for time variables (e.g. time of symptom onset, time of PCI).

2.3. Measurements

Patients were analyzed after stratification into 2 age groups (≤35 and >35). We measured differences in the clinical presentation, such as pain or signs of heart failure, and in the cardiovascular risk factors. We analyzed differences in the use of reperfusion therapies, including primary PCI (PCI was termed primary, when it constituted the initial reperfusion strategy and was performed within 24 h of symptom onset) or thrombolysis for the subgroup of patients with STEMI, and early PCI (defined as PCI within the first 24 h after hospital admission) in patients with NSTEMI/UA. We assessed the outcome which comprised in-hospital death and major adverse cardiac events (MACE). MACE were defined as the composite endpoint of re-infarction, stroke and/or in-hospital death.

2.4. Statistical analysis

The SPSS software (Chicago, Illinois; Version 15.0) was used for all statistical analyses. A P value of <0.05 was considered significant. Data are presented as percentages for discrete variables and as mean ± standard deviation and/or median for continuous variables. Differences in baseline characteristics between age groups were compared using unpaired t-test and Fisher's exact test.

3. Results

28,778 patients with ACS were enrolled in the AMIS Plus cohort between January 1, 1997, and October 1, 2008. Only 195 patients (0.7%) were younger than 35 years. Baseline characteristics of young patients as compared to patients aged 35 years and older are shown in Table 1. Female gender accounted for 14.9% of young patients, significantly (P<0.001) less than in older patients.

Chest pain was the most frequent symptom at hospital admission in both age groups, its prevalence, however, was significantly (P=0.003) higher in young patients (with 9 of 10 patients having chest pain). On the other hand, dyspnea and signs of heart failure were less common in younger patients. The proportion of young patients with dyspnea was approximately half of the 26.8% in older patients (P<0.001). Only few young patients (5.7%) presented with Killip class II or higher, whereas this proportion significantly (P<0.001) increased in older patients (Table 1). The time delay from symptom onset to hospital admission was not significantly different between young and older patients and not significantly different between young patients with and young patients without a family history of CAD.

Table 1
Baseline characteristics.

	Patients aged ≤35 years	Patients aged >35 years	P value
Mean age ± SD, years	31.2 ± 2.8	65.8 ± 12.9	<0.001
Female gender, % (no./no.)[d]	14.9 (29/195)	27.7 (7931/28,583)	<0.001
Clinical presentation at admission			
Chest pain, % (no./no.)[d]	91.6 (174/190)	83.7 (23,252/27,775)	0.003
Dyspnea, % (no./no.)[d]	12.8 (23/179)	26.8 (7074/26,408)	<0.001
Killip class I, % (no./no.)[d]	94.8 (181/191)	77.0 (21,741/28,218)	<0.001
Killip class II, % (no./no.)[d]	3.1 (6/191)	15.9 (4488/28,218)	
Killip class III, % (no./no.)[d]	0.0 (0/191)	4.5 (1267/28,218)	
Killip class IV, % (no./no.)[d]	2.1 (4/191)	2.6 (722/28,218)	
Cardio-pulmonary resuscitation, % (no./no.)[d]	4.2 (8/189)	3.6 (1005/27,723)	0.560
STEMI, % (no./no.)[d]	73.1 (141/193)	58.3 (16,613/28,501)	<0.001
NSTEMI/UA, % (no./no.)[d]	26.9 (52/193)	41.7 (11,888/28,501)	
ECG at admission			
Sinus rhythm, % (no./no.)[d]	97.3 (142/146)	91.0 (21,137/23,218)	0.005
Atrial fibrillation, % (no./no.)[d]	0.7 (1/146)	5.2 (1216/23,218)	0.008
Wide QRS complex tachycardia, % (no./no.)[d]	0.0 (0/146)	0.6 (146/23,218)	1.000
ST-segment elevation, % (no./no.)[d]	73.1 (141/193)	54.5 (15,511/28,463)	<0.001
ST-segment depression, % (no./no.)[d]	15.8 (30/190)	25.3 (6913/27,337)	0.003
Q waves, % (no./no.)[d]	20.7 (40/193)	18.8 (5365/28,462)	0.522
T wave changes, % (no./no.)[d]	26.8 (51/190)	25.0 (6845/27,338)	0.561
Left bundle branch block, % (no./no.)[d]	0.5 (1/193)	5.2 (1478/28,449)	0.001
Right bundle branch block, % (no./no.)[d]	3.7 (7/190)	4.2 (1142/27,329)	1.00
Past medical history			
Previous CAD, % (no./no.)[d]	15.6 (21/135)	39.3 (8668/22,078)	<0.001
Current smoking, % (no./no.)[d]	77.2 (146/189)	37.7 (10090/26,794)	<0.001
Dyslipidemia, % (no./no.)[d]	44.0 (80/182)	57.1 (14,554/25,503)	<0.001
Hypertension, % (no./no.)[d]	17.8 (33/185)	57.7 (15,757/27,306)	<0.001
Family history of CAD[a], % (no./no.)[d]	55.0 (33/60)	34.4 (3361/9761)	0.001
Diabetes, % (no./no.)[d]	6.3 (12/191)	20.0 (5524/27,595)	<0.001
Overweight[b], % (no./no.)[d]	57.8 (89/154)	64.2 (14,642/22,819)	0.108
Cocaine abuse[c], % (no./no.)	5.3 (1/19)	0.3 (7/2240)	0.065

Abbreviations: BMI, body mass index; CAD, coronary artery disease; NSTEMI, non-ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction; UA, unstable angina.

[a] Assessed since 2005.

[b] Overweight defined as BMI >25 kg/m^2.

[c] Data available only for restricted group of patients.

[d] no./no. = number of patients with characteristic/number of patients with available data.

The distribution of STEMI and NSTEMI/UA was significantly different (P<0.001) between young and older patients: 73.1% of young patients showed STEMI whereas this proportion decreased to 58.3% in patients older than 35 years. In nearly all young patients criteria for STEMI involved ST-segment elevation on initial ECG and left bundle branch block was present in only 0.5%. In the older age group, a significantly (P=0.001) higher proportion of patients presented with left bundle branch block.

Though significantly (P<0.001) less than in older patients, 15.6% of young patients had a history of previous CAD. Current smoking was the most prevalent cardiovascular risk factor in young patients with 3 of 4 young patients being current smokers. This prevalence was significantly (P<0.001) higher than in the older age group. 55.0% of young patients had a family history of CAD which was significantly (P=0.001) more than in older patients. Among young patients with a family history of CAD, the proportion of smokers was 72.7%. This proportion was not significantly different (P=0.358) from the proportion of smokers among young patients without a family history of CAD. The prevalence of overweight among young patients with ACS was almost as high as in older patients (57.8% vs. 64.2%; P=0.108). Though cocaine abuse was not assessed in all patients, cocaine abuse seems to be a relevant causative agent in younger patients (Table 1). Of all 8 patients with cocaine abuse before hospital admission, the

oldest patient was 51 years old. In one 30 year old female patient without cardiovascular risk factors, STEMI occurred during spontaneous delivery. Coronary angiography revealed a two-vessel CAD.

Beginning from 2005, angiographic findings at hospital admission were assessed. Young patients showed less diffuse atherosclerotic lesions as compared to patients of the older age group: in young patients, 75% showed one-vessel CAD and 23.2% two- or three-vessel CAD, whereas among older patients 38.6% had one-vessel and 59.2% two- or three-vessel CAD ($P<0.001$). The proportion of young patients with normal coronary arteries was 1.8%.

The use of different therapies in patients with STEMI and those with NSTEMI/UA is shown in Table 2. Though there was a tendency of a more frequent use of primary PCI and thrombolysis in young patients with STEMI, the differences were not significant. In patients with NSTEMI/UA, younger patients were more likely to receive a PCI (early as well as any PCI during the index hospitalization).

Outcome was excellent in young patients (Table 2). Only 3 patients (1.5%) died during the index hospitalization, significantly ($P=0.001$) less than in the older age group. Two of these patients were male (32 and 29 years old) both of whom experienced ventricular fibrillation as primary manifestation of the ACS and underwent cardiac resuscitation before standard therapy could be initiated. Both patients died on the day they were admitted to the hospital. The third patient who died was female (31 years old) and suffered from Marfan syndrome. She had aortic dissection 10 years before the index hospitalization and died on the first day of her STEMI. MACE occurred in only 2.1% of young patients. We observed a more than fourfold increase to 9.0% in the older age group ($P=0.001$).

4. Discussion

Our analysis of 195 young patients with ACS showed that these patients differed from older ACS patients in several ways. First, they presented very commonly with chest pain, whereas signs of heart failure were rarely found. Second, young patients with ACS were likely to experience STEMI. Third, smoking, family history of CAD, dyslipidemia, and/or overweight were the most important cardiovascular risk factors in young patients with ACS. Cocaine abuse was a further relevant risk factor. Fourth, young patients with ACS received guideline-recommended treatment and had an excellent outcome. We believe that our results add to the literature in showing these data on young patients across the whole spectrum of ACS.

In this study, chest pain was the most common symptom of ACS in young patients. In the literature, comparatively little data was available regarding the prevalence of chest pain in ACS. Most previous studies reporting data on chest pain focused on patients with myocardial infarction and were published in the 1990s or earlier [1,2]. In accordance with previous studies on myocardial infarction, signs of heart failure increased in the older age group, most probably due to a greater prevalence of previous or advanced CAD resulting in a lower ejection fraction [2,11]. Interestingly, the time delay between symptom onset and hospital admission was not significantly different between young patients with and without a family history of CAD. The question arises whether young patient did not learn from their parents.

Only one previous study assessed the proportion of patients with STEMI [11]. The prevalence was nearly 80%. In our study, we affirm this finding but extend it to young patients across the whole spectrum of ACS. Seven of ten young patients with ACS had STEMI. On the pathophysiologic level, this might be the consequence of a lower prevalence of moderate-to-severe stenoses in younger patients [21].

Most evidence from previous studies was available concerning cardiovascular risk factors [1–12]. Smoking and dyslipidemia have been reported as the most important cardiovascular risk factors of the young patient with myocardial infarction [1–12]. In our study, current smoking was also the most prevalent risk factor. Three of four young patients with ACS were smokers. Dyslipidemia was also highly prevalent in the young patients of our study. A family history of CAD is generally considered one of the three most important risk factors in young patients [1,2,4–6,8–10,12]. We confirm this previous finding and extend the knowledge of cardiovascular risk factors to the young patient across the whole spectrum of ACS. When considering the similar proportion of smokers among young patients with and without family history of CAD, it seems that young patients do not learn from their parents.

In this study, only 1.8% of young patients showed normal coronary arteries at coronary angiography. This percentage is low compared to the proportions found in previous studies [22,23]. The difference might be due to different inclusion criteria.

Regarding outcome, our results were in concordance with the few previous studies reporting results on mortality and MACE [1,2,9–12]. The favourable outcome among young patients might be the consequence of a typical clinical presentation giving rise to fast supply of treatment. As shown in this and a previous study, young patients are more likely than older patients to receive guideline-recommended treatment [13]. Furthermore, we hypothesize that the favourable outcome might also be related to the lower prevalence of extensive CAD in younger patients. This might also be an explanation for the similar or even better long-term prognosis of STEMI as compared to NSTEMI found in registries [24,25].

Our study exhibits potential limitations. First, it is conceivable that unmeasured factors may have influenced our study findings. However, 76 hospitals prospectively enrolled patients with ACS in this study. Approximately 11,000 patients experience an ACS treated in a Swiss hospital each year [26]. It is estimated that the cohort embraced 40% of all patients being treated for an ACS in the participating institutions and 20% of all patients being treated for an ACS in Switzerland during the investigated time period. Furthermore, data quality of this study is excellent as shown by the κ scores (>0.8 for baseline data and therapeutic interventions). As a second limitation, this Swiss cohort may not accurately reflect the situation in other countries thus limiting its generalizability. But overall, the results are concordant with those from other countries [1–12]. Thus

Table 2
Treatment and outcome.

	Patients aged ≤35 years	Patients aged >35 years	*P* value
Patients with STEMI			
No. of patients with STEMI	142	16,613	
Treatment			
Primary PCI[a], % (no./no.)[c]	53.6 (75/140)	48.6 (8057/16,566)	0.270
Thrombolysis, % (no./no.)[c]	25.5 (36/141)	20.8 (3447/16,583)	0.174
Outcome			
In-hospital mortality, % (no./no.)[c]	2.1 (3/142)	8.0 (1333/16,613)	0.005
MACE[b], % (no./no.)[c]	2.9 (4/139)	10.4 (1689/16,274)	0.002
Patients with NSTEMI/UA			
No. of patients with NSTEMI/UA	52	11,888	
Treatment			
Early PCI[a], % (no./no.)[c]	59.6 (31/52)	34.5 (4087/11,836)	<0.001
Any PCI[a], % (no./no.)[c]	79.2 (38/48)	61.5 (6354/10,337)	0.013
Outcome			
In-hospital mortality, % (no./no.)[c]	0.0 (0/52)	5.2 (622/11,888)	0.114
MACE[b], % (no./no.)[c]	0.0 (0/52)	7.0 (812/11,666)	0.049

Abbreviations: MACE, major adverse cardiac events; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction; UA, unstable angina.

[a] PCI was termed primary, when it constituted the initial reperfusion strategy and was performed within 24 h of symptom onset; early PCI was defined as PCI within the first 24 h after hospital admission; any PCI was defined as any PCI during the course of the index hospitalization.

[b] MACE were defined as composite endpoint of re-infarction, stroke and/or in-hospital death.

[c] no./no. = number of patients with a characteristic/number of patients with available data.

the results may probably be generalized to other similar countries. Third, not all variables used in this study have been assessed since the start of the AMIS Plus Registry in 1997. Therefore, denominators for some variables may be lower than the total number of participating patients.

Our study has clinical implications. First, most young patients have STEMI amenable to primary reperfusion therapy. Rapid detection of STEMI in young patients with chest pain is therefore vital in order not to delay hospital admission and primary reperfusion therapy which was shown to improve outcome markedly in these patients [27]. Second, smoking and cocaine abuse are modifiable risk factors. Our study supports the necessity of promoting smoking prevention programmes in the young population [28,29]. Cocaine abuse deserves more attention and should be asked for at hospital admission. Third, the prevalence of being overweight in young patients of this study was much higher than the prevalence of being overweight in a comparable young Swiss population without CAD [30]. Therefore, our findings emphasize the importance of implementing successful childhood overweight prevention programmes [31–34]. Theoretically, all these measures should markedly reduce the incidence of CAD in the young population.

In conclusion, young patients with ACS differ from older patients in their clinical presentation, treatment, and outcome. Young patients often present with STEMI, receive early aggressive treatment, and have a favourable outcome. Primary prevention of smoking, dyslipidemia and being overweight should be more aggressively promoted in an early period of life.

Acknowledgments

The AMIS Plus cohort study is funded by unrestricted grants from the Swiss Heart Foundation and from Abbott, Aotec, Astra-Zeneca, Biotronik, Bristol-Myers Squibb, Essex/MSD, GlaxoSmithKline, Guidant, INVATEC, Johnson&Johnson — Cordis Division, A Menarini, Medtronic, Merck Sharp & Dohme-Chibret, Novartis, Pfizer, Sanofi-Aventis, Schering, Servier, SPSS, St. Jude Medical, and Takeda Pharma, all in Switzerland. Andreas Schoenenberger was supported by a Forschungskolleg Geriatrie Grant from the Robert Bosch Foundation, Stuttgart, Germany. The supporting institutions did not have any role in the design and conduct of the study; in the collection, management, analysis, and interpretation of the data; and in the preparation, review, or approval of the manuscript. All authors disclose any conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject of the manuscript.

The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology [35].

Appendix A

Steering committee

P Erne, President, Lucerne; O Bertel, Zurich; F Eberli, Zurich; M Essig, Zweisimmen; P-F Keller, Geneva; F Gutzwiller, Zurich; P Hunziker, Basel; M Maggiorini, Zurich; G. Pedrazzini, Lugano; H Rickli, St. Gallen; J-C Stauffer, Lausanne; P Urban, Geneva; S Windecker, Bern.

Participating centres

The following hospitals participated from 1997–2008 in the AMIS registry on which this report is based (in alphabetical order): Affoltern am Albis, Bezirkspital (F Hess), Altdorf, Kantonsspital (R Simon), Altstätten, Kantonales Spital (PJ Hangartner/M Rhyner), Aarau, Kantonsspital (P Lessing), Baden, Kantonsspital (M Neuhaus/U Hufschmid), Basel, Kantonsspital (P Hunziker), Basel, St. Claraspital (C Grädel), Bern, Beau-Site Klinik (A Schönfelder), Bern, Inselspital (B Meier/S Windecker), Biel, Spitalzentrum (H Schläpfer), Brig-Glis, Oberwalliser Kreisspital (D Evéquoz), Bülach, Spital (R Pampaluchi/A Ciurea-Löchel/M Kruhl/A Vögele), Burgdorf, Regionalspital Emmental (D Ryser), Chur, Rätisches Kantons- und Regionalspital (P Müller), Chur, Kreuzspital (V Wüscher/R Jecker), Davos, Spital (G Niedermaier), Dornach, Spital (A Koelz/H Lederer), Einsiedeln, Regionalspital (S Stäuble), Flawil, Kantonales Spital (T Langenegger/J Haarer), Frauenfeld, Kantonsspital (HP Schmid), Fribourg, Hôpital cantonal (B Quartenoud), Frutigen, Spital (S Moser/K Bietenhard), Genève, Hôpitaux universitaires (HUG) (JM Gaspoz/P-F Keller), Glarus, Kantonsspital (W. Wojtyna), Grenchen, Spital (P Schlup/A Oestmann/B Oertli/R Schönenberger), Grosshöchstetten, Bezirksspital (C Simonin), Heiden, Kantonales Spital (R Waldburger), Herisau, Kantonales Spital (P Staub/M Schmidli), Interlaken, Spital (P Sula/EM Weiss), Jegenstorf, Spital (H Marty), La Chaux-de-Fonds, Hôpital (H Zender), Lachen, Regionalsspital (I Poepping/C Steffen), Langnau im Emmental, Regionalspital (J Sollberger/A Hugi), Laufenburg, Gesundheitszentrum Fricktal (E Koltai), Lugano, Cardiocentro Ticino (G Pedrazzini), Luzern, Kantonsspital (P Erne), Männedorf, Kreisspital (J von Meyenburg/T Luterbacher), Martigny, Hôpital régional (B Jordan), Mendrisio, Ospedale regionale (A Pagnamenta), Meyrin, Hôpital de la Tour (P Urban), Monthey, Hôpital du Chablais (P Feraud), Montreux, Hôpital de Zone (E Beretta), Moutier, Hôpital du Jura bernois (C Stettler), Münsingen, Regionales Spital Zentrum (F Repond), Münsterlingen, Kantonsspital (F Widmer), Muri, Kreisspital für das Freiamt (A Spillmann/F Scheibe/K Rudaz-Schwaller), Nyon, Group. Hosp. Ouest lémanique (R Polikar), Olten, Kantonsspital (S Bassetti), Rheinfelden, Gesundheitszentrum Fricktal (HU Iselin), Rorschach, Kantonales Spital (M Pfister/A Fischer), Samedan, Spital Oberengadin (P Egger), Sarnen, Kantonsspital Obwalden (T. Kaeslin), Schaffhausen, Kantonsspital (R. Frey), Schlieren, Spital Limmattal (B Risti/V Stojanovic/T Herren), Schwyz, Spital (P Eichhorn), Scuol, Ospidal d'Engiadina Bassa (G Flury/C Neumeier), Solothurn, Bürgerspital Solothurn (P Hilti/A Grât, R. Schönenberger), St. Gallen, Kantonsspital (W Angehrn/H Rickli), Sursee, Spital (S Yoon), Tiefenau, Tiefenauspital (P Loretan), Thun, Spital (U Stoller), Thusis, Krankenhaus (UP Veragut), Uster, Spital (D Maurer/J Muntwyler/J Hellermann), Uznach, Kantonales Spital (A Weber), Wädenswil, Schwerpunktspital Zimmerberg-Horgen (G Garzoli/B Kälin), Walenstadt, Kantonales Spital (H Matter/D Schiesser), Wetzikon, GZO Spital (M Graber), Winterthur, Kantonsspital (A Haller), Wolhlusen, Kantonales Spital (M Peter), Zofingen, Spital (HJ Vonesch/HJ Meier/S Gasser), Zollikerberg, Spital (P Siegrist/R Fatio), Zug, Kantonsspital (M Vogt/D Ramsay), Zürich, Klinik im Park (O Bertel), Zürich, Universitätsspital Zürich (F Eberli/M Maggiorini), Zürich, Stadtspital Triemli (O Bertel/F Eberli), Zürich, Stadtspital Waid (M Brabetz/S Christen).

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