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Improving care for acutely presenting older patients visiting the emergency department: the implementation of geriatric screening in routine care

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Citation

Blomaard, L. C. (2021, June 30). *Improving care for acutely presenting older patients visiting the emergency department: the implementation of geriatric screening in routine care*. Retrieved from <https://hdl.handle.net/1887/3185904>

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Issue date: 2021-06-30



Chapter 6

Implementation of the APOP screening program in routine Emergency Department care: a before-after study

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Published in Zeitschrift für Gerontologie und Geriatrie – 2021 Mar;54(2):113-121.

ABSTRACT

Objective: The aim of this study was to evaluate the effects of implementation of the Acutely Presenting Older Patient (APOP) screening program for older patients in routine emergency department (ED) care shortly after implementation.

Methods: We conducted an implementation study with before-after design, using the plan-do-study-act (PDSA) model for quality improvement, in the ED of a Dutch academic hospital. All consecutive patients ≥ 70 years during 2 months before and after implementation were included. The APOP program comprises screening for risk of functional decline, mortality and cognitive impairment, targeted interventions for high-risk patients and education of professionals. Outcome measures were compliance with interventions and impact on ED process, length of stay (LOS) and hospital admission rate.

Results: Two comparable groups of patients (median age 77 years) were included before ($n=920$) and after ($n=953$) implementation. After implementation 560 (59%) patients were screened of which 190 (34%) were high-risk patients. Some of the program interventions for high-risk patients in the ED were adhered to, some were not. More hospitalized patients received comprehensive geriatric assessment (CGA) after implementation (21% before vs. 31% after; $p=0.002$). In 89% of high-risk patients who were discharged to home, telephone follow-up was initiated. Implementation did not influence median ED LOS (202 min before vs. 196 min after; $p=0.152$) or hospital admission rate (40% before vs. 39% after; $p=0.410$).

Conclusion: Implementation of the APOP screening program in routine ED care did not negatively impact the ED process and resulted in an increase of CGA and telephone follow-up in older patients. Future studies should investigate whether sustainable changes in management and patient outcomes occur after more PDSA cycles.

INTRODUCTION

Older patients form an increasing proportion of emergency department (ED) visitors worldwide and are at higher risk of adverse health outcomes compared to younger patients¹. The presence of multiple comorbidities, cognitive disorders and atypical disease presentation requires more staff time and resources², increases ED length of stay (LOS) and poses organizational challenges^{3,4}. A comprehensive geriatric assessment (CGA) is an effective method to improve older patients' outcomes⁵, but CGA is time-consuming and therefore cannot be applied routinely to every older patient attending the ED. Alternatively, a two-step approach can be used with identification of patients with the highest risk of adverse outcome as a first step, followed by targeted interventions according to the principles of CGA^{6,7}. To this end, several screening instruments and interventions have been specifically developed for older patients in the ED^{8,9}, yet few have successfully been disseminated in clinical ED practice.

The acutely presenting older patient (APOP) screening program consists of screening with the APOP screener followed by interventions aimed to improve overall ED care and follow-up of older patients¹⁰. The program was implemented in routine ED care in the Leiden University Medical Center (LUMC) together with an education program to enhance awareness amongst nurses and doctors working in the ED. There is extensive evidence that effective implementation of complex interventions can be associated with better outcomes in various settings outside the ED, which implicates that evaluation of implementation is an absolute necessity in program evaluation^{11,12}. One of the important reasons why screening of older ED patients is rarely carried out in routine care, is the fact that little is known about the practical issues and feasibility of implementation in everyday ED practice¹³, although it was recently shown that administration of the APOP screener is feasible in routine ED practice¹⁴.

In the present study we aimed to evaluate the effects of implementation of the APOP screening program in routine ED care by assessing the compliance with interventions in the ED, during hospital admission and after discharge, and the impact on process of care measures, shortly after implementation. We hypothesized that the implementation of the screening program would not negatively influence the usual ED process, for example no prolongation of the ED stay and it would result in improvement of the care for older patients, for example the increase in geriatric assessments.

METHODS

Study design

This was a prospective study investigating the effects of implementation of the APOP screening program with a before-after design, conducted in the ED of the LUMC. The APOP program was kicked-off as part of routine ED care on 1 March 2018. Data were collected during a 2-month observation period before implementation (“before”) from 4 December 2017 until 2 February 2018, and during 2 months after implementation (“after”) from 2 April 2018 until 3 June 2018. All consecutive patients aged 70 years and older attending the ED during these periods were included in the study. The medical ethics committee of the hospital waived the necessity for formal approval of this study as it closely follows routine care. All patient data were anonymized before analyses were executed. The standards for reporting implementation studies (StaRI) were used to present the study¹⁵.

Context

The APOP screening program was implemented in the context of an ageing Dutch population where the financial crisis forced governments to stimulate older patients to stay at home longer, while the capacity of home care and nursing homes decreased seriously in the last years. The Netherlands has ~38,000 hospital beds, ~115,000 nursing home beds and ~13,000 general practitioners available for a population of 17 million people. The increased number of older patients presenting to the ED has been a constant debate in politics, and older patients are believed to be the cause of increasing overcrowding of Dutch EDs. This resulted in more attention for older ED patients and an upcoming motivation of ED care providers to improve care for this population.

Setting

The LUMC is a tertiary care centre with ~26,000 ED visits per year, of which approximately 20% are patients aged ≥ 70 years. In the ED, a triage nurse prioritizes patients based on their disease severity, using the Manchester Triage System (MTS)¹⁶. Patients who bypass ED triage are patients eligible for thrombolytic treatment and patients with an indication for telemetry or cardiac catheterization who are admitted to the emergency cardiac care unit. The ED is staffed each day of the week for 24 h by ED nurses, ED physicians, ED residents and residents of other specialties. When hospitalization is indicated after ED treatment, most patients are admitted to the acute medical unit (AMU), which is a 24-bed unit for admission up to 48h of medical, surgical and selected neurological patients.

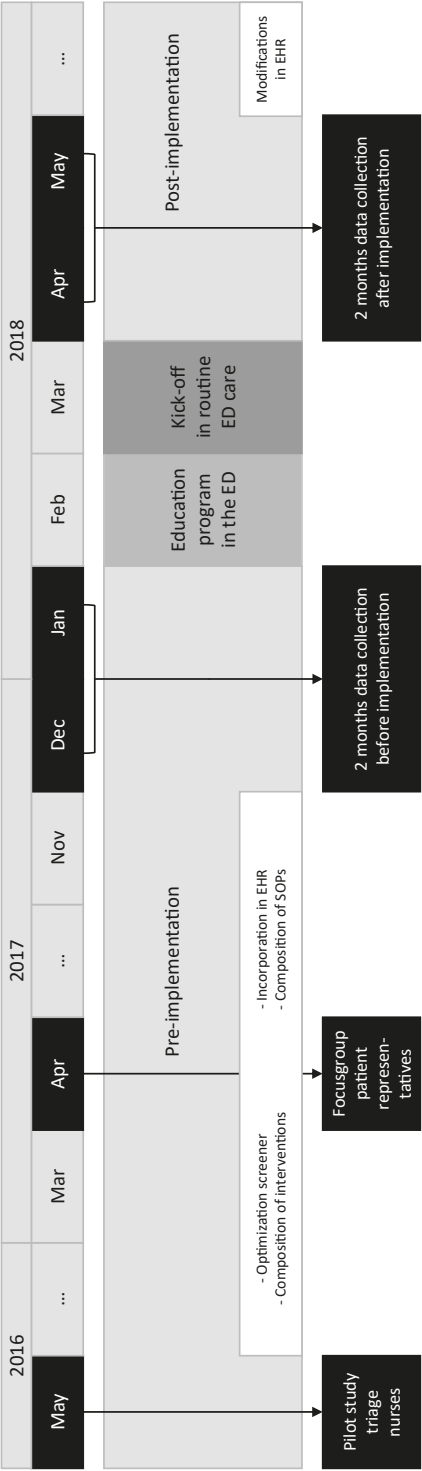


Figure 1. Overview of the implementation process and data collection periods. Data were collected in multiple periods during the implementation process. In the present study, we evaluated data collected of patients aged ≥ 70 years visiting the emergency department (ED) during the 2-month observation periods “before” and “after” implementation of the APOP screening program. Abbreviations: EHR = electronic health record, SOP = standard operating procedure.

Implementation strategy

The implementation strategy was guided by the plan-do-study-act (PDSA) model for quality improvement^{17,18}. In the pre-implementation phase, we used recurring PDSA cycles and assessed barriers and facilitators of the program from pilot studies with ED nurses and focus groups with patient representatives (Figure 1). The received input was taken into account during the optimization of the APOP-screener¹⁰ and the facilitation of the program in the electronic health records (EHR) and standard operating procedures (SOP). We carried out an education program for ED personnel to enhance awareness during 1 month before the kick-off in routine care. A complete description of the implementation strategy and the education program¹⁹ can be found in Supplementary text 1.

Outline of the APOP screening program

The APOP screening program was developed for ED patients aged ≥ 70 years and consists of three parts (Figure 2):

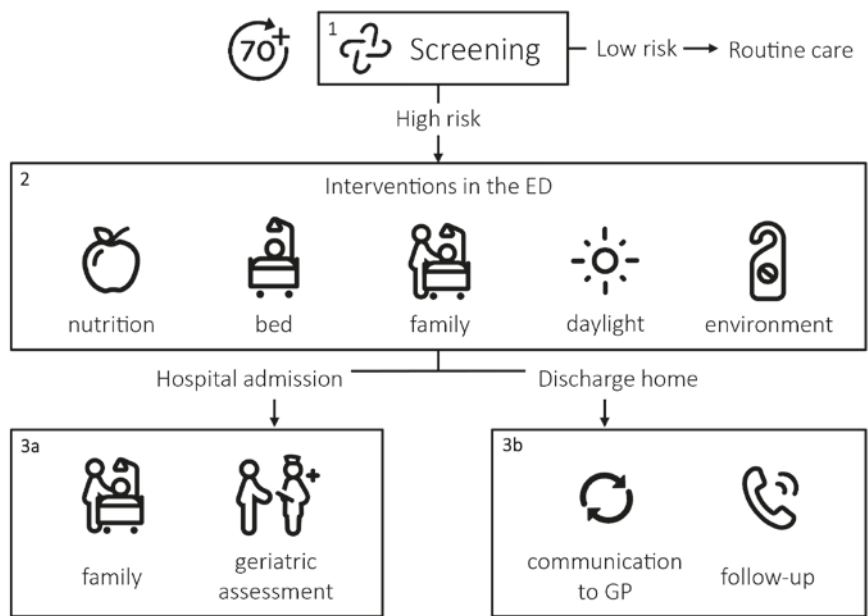


Figure 2. Overview of the acutely presenting older patient (APOP) screening program. The APOP screening program consists of three parts: firstly, screening older patients for risk of functional decline/mortality and signs of impaired cognition, secondly targeted interventions for high-risk patients in the emergency department (ED) and thirdly interventions for high-risk patients who are hospitalized or discharged home.

1. Screening

The APOP screener can be administered in 90s and identifies the patients' individual risk of 90-day functional decline and/or mortality and signs of impaired cognition in the

ED¹⁰. All patients aged ≥ 70 years are eligible for screening after routine ED triage. In this study we excluded patients who bypassed triage and patients who were triaged to the immediate urgency level (MTS category “red”), because the APOP screener was not developed and validated for this population. Screening results are saved in the EHR and are visible for all care providers. Patients with a low risk according to screening receive routine care. Patients are at high risk when having a 45% or higher risk of functional decline and/or mortality within 90 days or when having signs of impaired cognition^{10;14}.

2. Interventions for high-risk patients in the ED

A high risk leads to follow-up actions and interventions. Interventions were based on recommendations from geriatric emergency medicine guidelines^{6;20} and were adjusted for use in the Dutch ED setting (Supplementary text 1). The APOP program is a broader program, but in this study we describe the interventions which were evaluated. A full description of these interventions is shown in Supplementary table 2. Physicians and nurses are advised to execute interventions in the ED to increase comfort, family involvement and delirium prevention.

3a. Interventions for high-risk patients admitted to the hospital

Interventions can be conducted in an early phase when high-risk patients are hospitalized. Care providers are advised to avoid a prolonged ED LOS and to arrange family involvement during transfer to the ward. The geriatric consulting team is informed automatically by the EHR to arrange a comprehensive geriatric assessment (CGA) during hospital admission.

3b. Interventions for high-risk patients discharged home from the ED

The GP is informed about the high-risk result automatically by the EHR in the discharge letter from ED physicians. For high-risk patients who are discharged home from the ED, telephone follow-up is initiated within 24h after discharge. The ED nurses contact patients to find out if they have remaining questions about the ED treatment and if they need any help (i.e. clarification of instructions).

Outcomes

The present study had the following outcome measures: Firstly, compliance with interventions of executed interventions in the ED, during hospital admission or after discharge. Secondly, impact on process of ED care measures: ED LOS and hospital admission rate.

Data collection

Patient characteristics and organizational factors

In order to evaluate potential differences between the two data collection periods, we collected patient characteristics and organizational factors before and after

implementation. Patient characteristics were collected from the EHR on demographics (age, gender) and severity of disease (Charlson Comorbidity Index (CCI)²¹, arrival by ambulance, MTS triage urgency and chief complaint¹⁶ and the specialist first assigned to treat the patient in the ED). To measure organizational factors on a patient level, we used real-time observations in the ED. During the “before” and “after” data collection periods medical students were present in the ED 7 days per week (8.00a.m. – 11.00p.m.). Observed organizational factors were: the total number of ED patients at arrival day, the actual number of ED patients at arrival time, the number of occupied AMU beds at arrival time and the national emergency department overcrowding score (NEDOCS) at arrival and departure time²². Our hospital uses an adapted, but not yet validated, NEDOCS applicable for Dutch EDs (NEDOCS 0-50=normal, 51-100 busy, 101-140 overcrowded, 141-180 severe, >181 disaster).

1. Screening rate

After implementation, data were collected on the number of patients with executed APOP screening and the results of screening. The number of screened patients divided by the total number of older patients per day yielded the screening rate¹⁴.

2. Compliance with interventions – in the ED

The compliance with interventions was measured by absolute numbers of executed interventions in real-time observed older patients “before” and “after” implementation. Additionally, we evaluated the compliance in high-risk patients after implementation. Observations of executed interventions were done from a central place in the ED where most treatment rooms were visible. During the whole ED visit we observed whether older patients: 1) were offered nutrition, 2) were placed in a bed instead of a gurney, 3) had family present and 4) were placed in a room with daylight. The stressfulness of the ED environment was measured by the number of involved care providers, the number of treatment room door movements and the proportion of time the treatment room door was open for whole ED LOS. ED personnel were not informed about the reason for observation.

3a. Compliance with interventions – hospital admission

For older patients hospitalized in our hospital wards, we observed real time the accompaniment by family when leaving the ED. Consultation of the geriatric team for CGA during admission was collected from the EHR. The compliance was quantified by the number of patients who received CGA divided by the total number of hospitalized older patients.

3b. Compliance with interventions – discharge home

The novel interventions communication to GP and telephone follow-up were collected after implementation from the EHR. The compliance of communication to GP was quantified by the number of high-risk patients with an automatically incorporated discharge letter divided by the total number of high-risk discharged patients. Telephone

follow-up compliance was quantified by the number of high-risk patients who received follow-up divided by the total number of high-risk patients discharged home.

Impact on process of ED care

Process of care measures were collected from the EHR and were available for all triaged older ED patients before and after implementation. The ED LOS was measured by subtraction of the ED arrival time from the departure time. Hospital admission rate was measured by the number of patients hospitalized from the ED divided by the total number of older ED patients, during the before and after observation period.

Sample size calculation

The sample size was calculated on ED LOS and hospital admission rate. In a previous analysis of our ED, older patients had a median ED LOS of 189 minutes (interquartile range, IQR, 125-264 min) and the hospital admission rate was 43%²³. We considered a change of 15 min ED LOS and 7% hospital admission rate as relevant. To detect a difference for the groups before and after with 80% power and 5% significance level, per group 891 patients were needed for ED LOS and 796 patients for hospital admission rate.

Statistical analyses

Continuous data are presented as mean (standard deviation, SD) if normally distributed, and as median (IQR) if skewed. Categorical data were presented as numbers and percentages (n, %). The following statistical tests were used to assess differences in patient characteristics, organizational factors and compliance with interventions between the after and before period: independent samples t-test for normally distributed data, Mann-Whitney U-test for skewed data and χ^2 -test for categorical data.

To analyze the impact on process of ED care measures univariable logistic regression was performed, with ED LOS (<240 min, \geq 240 min) and hospital admission (yes, no) as dependent variables and the inclusion period “after” vs. “before” as the independent variable of interest. With multivariable logistic regression we adjusted for age and gender (model 1) and for age, gender and all significantly different variables between the “after” and “before” period (model 2). The results are presented as odds ratios (OR) with 95% confidence interval (95% CI). A p-value <0.05 was determined as statistically significant. Statistical analyses were performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA).

RESULTS

During the 2-month observation period before implementation (“before”) 4614 patients visited the ED of which 920 (20%) were patients aged \geq 70 years who were triaged at

ED arrival. In the 2-month observation period after implementation (“after”) 953 out of 5188 (18%) ED patients were triaged patients aged ≥ 70 years. Of all triaged older patients, 62% (N=574) was observed “before” and 59% (N=560) “after” in order to evaluate the compliance with interventions (Figure 3).

Patient characteristics and organisational factors

Table 1 shows the characteristics and organisational factors on a patient level ‘before’ and ‘after’. The median age of patients was the same in both periods: 77 (73-83) years. Severity of disease indicators were comparable ‘before’ and ‘after’. Organisational factors ‘before’ and ‘after’ differed: the mean total number of ED patients per day was higher in the ‘after’ period (77 (10) before vs 83 (12) after; $p < 0.001$), but the median NEDOCS at time of ED departure was lower ‘after’ (62 (42-80) before vs 57 (38-72) after; $p = 0.001$).

1. Screening rate

During the 2-month observation period “after” implementation 560 (59%) of the 953 older patients were screened¹⁴. As a result of screening, 190 (34%) patients were classified as having a high risk, which made them eligible for interventions.

2. Compliance with interventions – in the ED

Compliance with interventions was evaluated by comparison of executed interventions between all real time observed older patients “before” and “after” (Table 2). In the “after” period older patients more often received nutrition in the ED (7% before vs. 12% after; $p = 0.004$). No improvements were found in nursing on a bed (35% before vs. 27% after; $p = 0.004$), family presence (89% before vs. 84% after; $p = 0.043$) and room with daylight (30% before vs. 34% after; $p = 0.235$). Proxies for stressfulness of the ED environment were better “after” for median number of door movements (40 (IQR 24-62) before vs. 25 (IQR 15-40) after; $p < 0.001$) and median number of involved staff (7 (IQR 5-10) before vs. 5 (IQR 4-7) after; $p < 0.001$).

3a. Compliance with interventions – hospital admission

In total 362 (40%) patients “before” and 368 (39%) patients “after” were admitted to the hospital. More hospitalized patients received CGA during admission “after” compared to “before” (21% before vs. 31% after; $p = 0.002$). Of a total of 92 admitted high-risk patients after implementation 65 (71%) patients received CGA.

3b. Compliance with interventions – discharge home

After implementation 80 high-risk patients were discharged home. In 57 (71%) patients, the high-risk result was communicated to the GP. Telephone follow-up was initiated in 70 (89%) patients. In total 81% of patients were reached by phone, of whom 37% of patients required clarification of home care instructions.

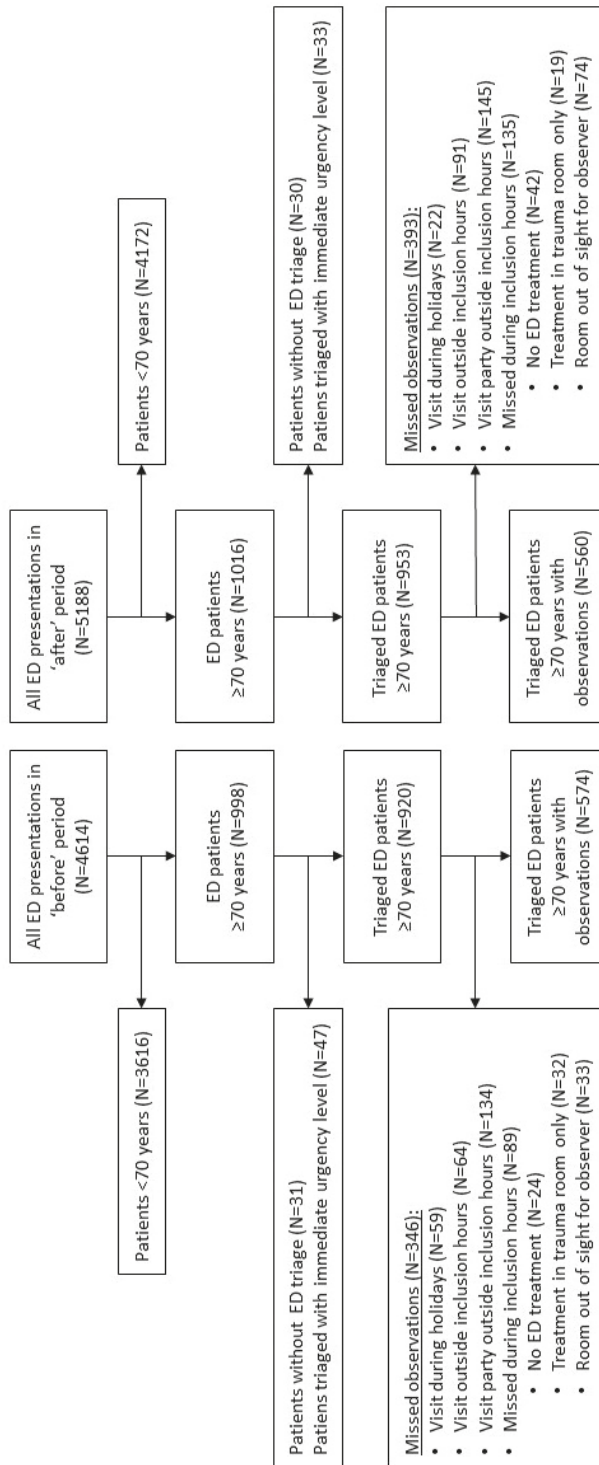


Figure 3. Flowchart of study population. All consecutive patients aged ≥ 70 years visiting the emergency department (ED) during the 2-month observation periods “before” and “after” implementation of the APOP screening program were included, except for patients who bypassed ED triage or patients who were triaged to the immediate urgency level. The screening rate was measured in triaged ED patients ≥ 70 years in the “after” period. Compliance with interventions was compared in the “before” and “after” period, using real-time observations of ED patients ≥ 70 years. Process of care measures were compared between all triaged ED patients ≥ 70 years in the “before” and “after” period.

Table 1. Patient characteristics and organizational factors before and after implementation

	Before (N=920)	After (N=953)	p-value
Demographics			
Age, years median (IQR)	77 (73-82)	77 (73-82)	0.372
Male, n (%)	439 (47.7)	471 (49.4)	0.460
Severity of disease indicators			
Charlson comorbidity index, median (IQR)	5 (4-6)	5 (4-7)	0.014
Arrival by ambulance, n (%)	316 (34.3)	293 (30.7)	0.096
Triage urgency, n (%)			0.585
> 1 hour (green and blue)	206 (22.4)	219 (23.0)	
< 1 hour (yellow)	449 (48.8)	443 (46.5)	
< 15 min (orange)	265 (28.8)	291 (30.5)	
Chief complaint, n (%)			0.533
Minor trauma	256 (28.0)	276 (29.3)	
Malaise	237 (25.9)	247 (26.2)	
Dyspnea	121 (13.2)	96 (10.2)	
Abdominal pain	97 (10.6)	91 (9.7)	
Chest pain	61 (6.7)	75 (8.0)	
Loss of consciousness	44 (4.8)	41 (4.4)	
Major trauma	13 (1.4)	15 (1.6)	
Mental health problems	6 (0.7)	10 (1.1)	
Other	80 (8.7)	91 (9.7)	
First assigned specialist in ED, n (%)			<0.001
ED physician	400 (44.3)	381 (42.1)	
Internal medicine	147 (16.3)	82 (9.1)	
Neurology	104 (11.5)	104 (11.5)	
Surgery	63 (7.0)	54 (6.0)	
Cardiology	59 (6.5)	71 (7.8)	
Other	129 (14.3)	214 (23.6)	
Observed organizational factors on patient level			
Total number of ED patients on arrival day, mean (SD)	77 (10)	83 (12)	<0.001
Number of ED patients at time of arrival, mean (SD)	13 (5)	13 (5)	0.170
Number of occupied AMU beds at time of arrival, mean (SD)	18 (4)	17 (4)	0.002
NEDOCS at time of starting medical treatment, median (IQR)	50 (27-70)	51 (28-68)	0.998
NEDOCS at time of departure from ED, median (IQR)	62 (42-80)	57 (38-72)	0.001

Demographics and severity of disease indicators were collected from electronic health records. Organizational factors were collected by real time observations during the ED visit.

Missing data

Before: 36 CCI, 5 chief complaint, 18 first assigned specialist, 4 number of ED patients at time of arrival, 4 number of occupied AMU-beds, 56 NEDOCS at time of start treatment, 57 NEDOCS at time of departure.

After: 56 CCI, 11 chief complaint, 47 first assigned specialist, 1 number of ED patients at time of arrival, 2 number of occupied AMU-beds, 75 NEDOCS at time of start treatment, 38 NEDOCS at time of departure.

N = number, IQR = interquartile range, SD = standard deviation, AMU = acute medical unit, NEDOCS = national emergency department overcrowding score, ED = emergency department.

Table 2. Compliance with interventions before vs. after implementation and compliance with interventions for high-risk screened patients after implementation

	Total group of observed older patients				High-risk screened observed patients	
	Before		After		p-value	
	Number observed	Compliance	Number observed	Compliance	Number observed	Compliance
Interventions in the ED						
Received nutrition, n (%)	540	37 (6.9)	528	63 (11.9)	111	27 (24.3)
Nursed on bed, n (%)	542	190 (35.1)	534	144 (27.0)	114	42 (36.8)
Family present, n (%)	536	475 (88.6)	518	437 (84.4)	113	98 (86.7)
Room with daylight, n (%)	523	158 (30.2)	508	171 (33.7)	108	44 (40.7)
Number of door movements, median (IQR)	523	40 (24-62)	513	25 (15-40)	111	31 (17-46)
Number of staff involved, median (IQR)	524	7 (5-10)	513	5 (4-7)	111	6 (4-8)
Proportion open door time (%)*, median (IQR)	423	15 (5-31)	508	16 (6-33)	110	22 (7-38)
Interventions at hospital admission^a						
Family present during admission, n (%)	216	174 (80.6)	174	147 (84.5)	46	37 (80.4)
Geriatric assessment, n (%)	343	72 (21.0)	365	114 (31.2)	91	65 (71.4)
Interventions at discharge home^b						
Communication to GP, n (%)	NA	NA	NA	NA	80	57 (71.3)
Telephone follow-up, n (%)	NA	NA	NA	NA	79	70 (88.6)

Total number of triaged patients ≥ 70 years before N=920; after N=953. Patients were observed real-time when visiting the ED between 8 a.m. and 11 p.m. Total number of observed triaged patients ≥ 70 years before N=574; after N=560. Total number of high-risk screened patients after implementation N=190.

N = number, IQR = interquartile range, NA = not applicable, GP = general practitioner, ED = emergency department.

*Proportion of time the treatment room door was open for whole ED length of stay in percentage.

^a Numbers of admitted patients in our hospital: before N=362, after N=368, high-risk screened patients N=92

^b Numbers of patients discharged home: before N=467, after N=488, high-risk screened patients N=80

Impact on process of ED care

In Table 3, process of ED care outcomes are compared for all included patients “before” and “after”. The median ED LOS was comparable between both groups with 202 min (IQR 133-290min) before vs. 196 min (IQR 133-265min) after; $p=0.152$. No prolonged ED LOS in the “after” period was found, after adjusting for possible confounders (OR 0.88 (95%CI 0.66-1.17), $p=0.371$) (Supplementary table 1). Hospital admission rates were comparable between both groups: 362 (40%) patients before vs. 368 (39%) patients after; $p=0.642$. After adjustment for possible confounders, the hospital admission rate in the “after” period was lower (OR 0.68 (95%CI 0.50-0.92), $p=0.013$).

Table 3. Process of ED care outcomes for patients before and after implementation

	Before (N=920)	After (N=953)	p-value
ED LOS (min), median (IQR)	202 (133-290)	196 (133-265)	0.152
Hospital admission after ED visit, n (%)	362 (40.0)	368 (38.9)	0.642

Missing data

Before: 2 ED LOS, 15 disposition after ED visit. After: 2 ED LOS, 8 disposition after ED visit.

N = number, IQR = interquartile range, LOS = length of stay, ED = emergency department.

DISCUSSION

In this study, the first effects of implementation of the APOP screening program in routine ED care were evaluated after 1 month by assessing the compliance with interventions and the impact on process of care measures. Interventions for high-risk patients in the ED were partly adhered to. Implementation of the program resulted in increased numbers of executed CGAs during hospitalization, communication of screening results to the GP and telephone follow-up after ED discharge. Implementation had no major effects on ED LOS and hospital admission.

To the best of our knowledge, this is the first study evaluating the implementation of a multicomponent screening program for older patients comprising screening and targeted interventions in routine ED care. In a recent substudy, we showed that implementation of the APOP screener was feasible with a screening rate of 59%¹⁴. Compared to other studies^{13;24;25}, our screening rate assessed shortly after implementation in routine ED care is relatively high. A screening rate of 100% is difficult to achieve because the time restraints inherent to a busy ED will prevent nurses to administer the screener. Since there are only few ED multicomponent studies published²⁶, we are only able to compare single components. In one study, telephone follow-up for all older ED patients resulted in 97% successfully contacted patients of which 40% required clarification of home care instructions²⁷, comparable to our results in high-risk older patients. The use of a clinical

risk prediction tool to select high-risk patients and target interventions to those patients most likely to benefit, the increased proportion of patients who receive CGA and the improved communication of screening results to the GP have been associated with improved patient outcomes in other settings^{8,9,28}. Definitive proof of (cost)effectiveness of the APOP screening program on patient outcomes, such as functional decline, should come from future studies, for example by using a multicenter stepped-wedge design²⁹.

The present study has several important findings for clinical practice. Firstly, implementation of screening in the ED resulted in improved execution of some individual interventions for older patients during their ED stay, i.e. adequate nutrition. However, the intervention “presence of family” did not increase, probably because this was already very high before implementation, i.e. a ceiling effect. The interventions “nursed on bed” and “room with daylight” also did not improve, probably because they were less feasible due to a lack of capacity (in our ED there are few beds and rooms with daylight available). Secondly, program implementation resulted in a significant increase of number of executed CGAs, which has been shown to be an effective method to improve outcomes⁵. In 71% of the high-risk patients CGAs were executed during hospitalization. Therefore, although interventions in the ED are not always executed, screening is a useful first step to ensure that high-risk patients receive optimal care during hospitalization. The same holds for high-risk patients discharged home from the ED, of which 79% were reached for telephone follow-up. Finally, implementation of our screening program did not lead to prolonged ED LOS or more hospital admissions. After adjustment for the small differences in the before and after group, there even seem to be less hospital admissions after which is important because impact on capacity is relevant to the feasibility and sustainability of the program.

The repetitive use of the PDSA model as a framework for our implementation strategy helped in understanding barriers and facilitators of implementation¹⁴. Continuation of future PDSA cycles can help to further improve compliance in our ED and can also help others to start implementation of this screening program elsewhere. The results of the present study are therefore the starting point for new evaluation cycles of the program. Until now, we mainly focused our implementation strategy on the ED nurses, the executors of the screening, which also resulted in mainly nurse-led interventions for high-risk patients. In future, we aim to focus more on physicians and use additional education to increase their awareness and promote a more holistic clinical assessment of older ED patients. Moreover, the interventions of our program were based on recommendations from international guidelines and quality indicators^{6,20} and could be updated according to recent recommendations³⁰. If other EDs would like to implement a screening program for older patients they can learn from our limitations and adjust their expectations accordingly, i.e. ensure the presence of rooms with daylight and focus on adequate nutrition during an ED stay.

Our study has several strengths. Firstly, to our best knowledge this is the first implementation study evaluating screening and interventions for older patients in routine ED care on a large scale, using real-time observations. Secondly, our implementation strategy was guided by the generally used PDSA model for quality improvement, resulting in good understanding of barriers and facilitators of implementation. Lastly, the screening program was implemented and evaluated in an unselected population of older ED patients, which is therefore generalizable to other ED populations.

Our study also has several limitations. Firstly, the before-after study design has time and seasonal variation as a limitation; however, there were no contextual changes between the two data collection periods. Also, we could not detect substantial differences in patient characteristics between the “before” and “after” group. Furthermore, the main outcome measures for the evaluation of the program were process measures – the proportion of hospitalized patients with geriatric assessment and the proportion of discharged patients with follow-up telephone calls – which are likely unaffected by time period or seasonal variation. Secondly, before implementation older patients could not be screened. Therefore, we could only compare compliance with interventions on the level of total group ED patients ≥ 70 years in the before and after periods. Small improvements in compliance with interventions in high-risk patients might therefore have been missed. Finally, the program was implemented in one tertiary care center which limits generalizability.

In conclusion, implementation of the APOP screening program in routine ED care did not negatively impact the ED process and resulted in an increase of CGA and telephone follow-up in older patients. Since this was a first evaluation shortly after implementation, future studies should investigate whether sustainable changes in management and patient outcomes occur after more PDSA cycles.

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Supplementary table 1. Risk of prolonged ED LOS and hospital admission after implementation compared to before (reference)

	OR (95% CI)	p-value
ED LOS ≥ 240 min “after” vs. “before”		
crude	0.86 (0.71-1.04)	0.126
model 1	0.86 (0.71-1.05)	0.134
model 2	0.88 (0.66-1.17)	0.371
Hospital admission “after” vs. “before”		
crude	0.96 (0.79-1.15)	0.642
model 1	0.95 (0.79-1.15)	0.621
model 2	0.68 (0.50-0.92)	0.013

Risk of prolonged ED LOS and hospital admission for patients included after implementation of the APOP screening program (N=953) compared to patients included before implementation (N=920).

Model 1: adjusted for age, gender

Model 2: adjusted for age, gender, CCI, first assigned specialist, total number of ED patients on arrival day, number of occupied AMU-beds at time of arrival and NEDOCS at departure time

OR = Odds ratio, CI = confidence interval, LOS = length of stay, ED = emergency department.

Supplementary text 1. Implementation strategy

Pre-implementation phase

Implementation planning for this study began with formal approval of the division boards of our hospital after the construction of a multidisciplinary project-team consisting of an ED physician, resident ED physician, ED-nurse, internist-geriatrician, geriatric nurse, AMU nurse, researchers and a general practitioner. Based on project-team experiences and literature the implementation strategy, outline of interventions and education program was developed. For the outline of the interventions we used usable elements of comprehensive geriatric assessment (CGA), taking into account the recommendations from international guidelines and quality indicators^{6;20}. There is no evidence yet whether these interventions improve outcomes for older patients. From the recommendations in international literature we selected interventions which were practicable to implement in routine care in the Dutch ED setting. In addition, we also selected interventions based on project-team experience and input from focus groups with patient representatives and general practitioners.

Implementation strategy

Our implementation strategy was guided by the plan-do-study-act (PDSA) model for quality improvement¹⁷. In the first PDSA cycle the use of the screening instrument in practice was evaluated in a pilot study with ED triage nurses. We assessed readiness to adopt the interventions, specific uptake goals and barriers and facilitators. The received input was taken into account during the development of the final screening instrument and the facilitation of the program¹⁰. For example, we excluded a question about polypharmacy in the final screening instrument because it took too much time to execute in practice. Triage nurses experienced a barrier to ask for dementia, one of the questions in the APOP screener. We therefore collected input from patient representatives on how this question could best be asked. Data was collected with focus group sessions with the older patient council of our hospital (Ouderenberaad Zorg en Welzijn Zuid-Holland Noord). Their input was written down in the standard operating procedures of the APOP screening program. The most important facilitator for use of the screening instrument in routine care turned out to be implementation in the electronic health records (EHR). This result was the starting point for following PDSA cycles in which the screening instrument, signals of high risk results and automatic orders were incorporated in the EHR.

Education program

Education was used to enhance awareness and increase knowledge of the ED team of different care needs of older people, especially aspects relating to frailty and geriatric syndromes, for which a broader, more holistic intervention is considered to be best practice. The other rationale for education was to influence adoption of the screening program by clarification of all program components. The education

program was developed during the pre-implementation phase by the members of the multidisciplinary project-team. Outline for the education program was based on recommendations from the Curriculum for Geriatric Emergency Medicine designed by the European Task Force for Geriatric Emergency Medicine¹⁹. We developed 6 education sessions of 15 minutes each on the following topics: 'Background of older patients visiting the ED', 'Vital signs in older patients', 'Cognitive disorders and delirium', 'Atypical presentations of older patients', 'How to administer the APOP-screener' and 'Interventions for high risk patients'. During one month before the kick-off of the APOP screening program all topics were presented several times to the ED nurses and physicians before every ED dayshift.

Post-implementation phase

After the kick-off of the APOP program at 1 March 2018 we highlighted the APOP screening program at start of every dayshift in the ED to make personnel aware of screening. Every day one project-team member was available for questions. Screening rates, tips from the project-team and feedback from patients were displayed in the ED newsletter and information board in the ED. We also collected feedback from ED personnel on the program at the end of the first screening month during a 3-hour session with ED physicians and nurses. From 2 April the data collection period for evaluation was started. During this 2 months we did not organize any education or feedback sessions and only observed routine care without interference from our project-team. After the data collection period we send out questionnaires to all ED nurses and physicians and collected their feedback on the program. Simultaneously, some modifications were made in the EHR, resulting in a clearer overview of patients screened and not yet screened during their ED stay.

Supplementary table 2. Overview of the APOP screening program advices for interventions

Result screening	Advices triage-nurse	Advices treating ED-nurse	Advices treating physician in ED
1. Low risk	Routine care	Routine care	Routine care
2. High risk on functional decline and/or mortality	<ul style="list-style-type: none">• Inform treating nurse and physician about high risk result.	<p>Routine care</p> <ul style="list-style-type: none">• Provide the patient with adequate nutrition and prevent dehydration as soon as possible.• Try to put the patient on a bed instead of a gurney.• Call family or caregiver if the patient arrived alone in the ED. <p>Admission</p> <ul style="list-style-type: none">• Soon anticipate on the patients destination after the ED visit and prevent a long length of stay in the ED.	<p>Routine care</p> <ul style="list-style-type: none">• Provide the patient with adequate nutrition and prevent dehydration as soon as possible.• Soon anticipate on the patients destination after the ED visit and prevent a long length of stay in the ED. <p>Discharge</p> <ul style="list-style-type: none">• Screening results are automatically communicated to the GP in the discharge letter. <p>Admission</p> <ul style="list-style-type: none">• The geriatric consulting team will receive an automatic order to arrange geriatric assessment during admission.

Result screening	Advices triage-nurse	Advices treating ED-nurse	Advices treating physician in ED
3. Signs of impaired cognition	<ul style="list-style-type: none"> Inform treating nurse and physician about high risk result. 	<ul style="list-style-type: none"> Provide the patient with adequate nutrition and prevent dehydration as soon as possible. Try to put the patient on a bed instead of a gurney. Call family or caregiver if the patient arrived alone in the ED. Start delirium preventive measures: <ul style="list-style-type: none"> Nurse the patient in a quiet room with normal daylight. Reduce the degree of stressfulness and noise of the ED environment: reduce sensory over-stimulation, keep the door closed and minimize the number of care providers. Take impaired cognition into account during history taking and instructional conversations. Soon anticipate on the patients destination after ED visit and prevent a long length of stay in the ED. 	<ul style="list-style-type: none"> Provide the patient with adequate nutrition and prevent dehydration as soon as possible. Try to minimize the number of care providers. Consider whether the patient has a delirium. Take impaired cognition into account during history taking and instructional conversations. Soon anticipate on the patients destination after ED visit and prevent a long length of stay in the ED. <p>Discharge</p> <ul style="list-style-type: none"> Screening results are automatically communicated to the GP in the discharge letter. <p>Admission</p> <ul style="list-style-type: none"> The geriatric consulting team will receive an automatic order to arrange geriatric assessment during admission
4. High risk on both domains (2 + 3)	Advices are the same as all mentioned above.	Advices are the same as all mentioned above.	Advices are the same as all mentioned above.