Diagnostic packages can be assigned accurately in emergency departments. A multi-centre cohort study

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ABSTRACT

INTRODUCTION: In the Region of Southern Denmark, the emergency departments categorise patients based on presenting symptoms and a proposed diagnostic package (n = 40) within each category. The diagnostic packages describe relevant clinical information and standard laboratory and other investigations to be performed. Allocation to the right diagnostic package is assumed to be associated with a higher quality. The aim of this study was to describe to which degree the assigned symptom-based diagnostic packages are related to relevant discharge diagnoses.

METHODS: This was a descriptive cohort study. The analysis was based on data on assigned diagnostic package, patient discharge diagnosis, hospital, gender, age, time of admission and discharge, length of stay, diagnostic package assigned, discharge diagnosis and co-morbidity. An acceptable standard for what would be an appropriate primarily diagnostic package was developed using a modified Delphi method.

RESULTS: A total of 16,543 patient contacts were identified. Women constituted 52.2% (n = 8,925) of the patients. The median age was 64 years and the median length of stay was one day. All diagnostic packages were represented. A total of 68% of the included patients had been assigned an acceptable diagnostic package (95% confidence interval: 67.2-68.7). We found an appropriate use of one of 30 diagnostic packages in more than 50% of the cases.

CONCLUSIONS: We found that 68% of the included patients were assigned an acceptable diagnostic package and that about 80% of all acute pathways were covered by 14 diagnostic packages.

FUNDING: The study was funded by Region of Southern Denmark.

TRIAL REGISTRATION: The study was registered with the Danish Data Protection Agency (No. 2008-58-0035). No further approval was required.

Patients arrive at emergency departments (EDs) with symptoms and problems rather than diagnoses. However, most existing research is performed using already established diagnoses, typically discharge diagnoses. Therefore, in emergency medicine, there is a need for knowledge of the ED patients' chief complaints rather than their discharge diagnoses. Besides, a systematic registration of ED patients' chief complaints can be used as a surveillance tool [1-3] and as a clinical support system in daily clinical practice [4].

In the Region of Southern Denmark (RSD), all five emergency departments have been using a management approach based on chief patient complaints since 2011. This approach includes categorising patients based on chief complaints and assigning them to a proposed diagnostic package specific to each complaint category [5, 6]. For each complaint, the diagnostic package describes which clinical information and standard laboratory and other investigations are to be performed: some within the first half hour and some within four hours after arrival in order to reach an action diagnosis. The symptom-based diagnostic packages were developed based on information from 10,070 patient contacts where the chief complaints were aggregated into 31 categories. Further processing by expert panels resulted in 40 diagnostic packages describing relevant diagnostic actions to be taken within certain time frames [7]. The overall objective of designing these packages was to ensure consistent quality around the clock. The packages were implemented in all five RSD EDs following thorough education of nurses and doctors in each department.

We assume that allocation to the right diagnostic package is associated with higher quality as well as increased effectiveness regarding the patient flow through the ED.

However, an important assumption underlying this argument is that there is an association between diagnostic package and end result (i.e. discharge diagnosis). To validate this assumption, we performed the present study with the aim of describing to which degree the assigned symptom-based diagnostic packages are related to relevant discharge diagnoses.

METHODS

We performed a descriptive cohort study of all patients assigned to a diagnostic package in the five EDs of the RSD (population 1,200,000 persons) between 1 April and 30 June 2013 (**Figure 1**).

The Danish healthcare system is tax-funded and provides free healthcare for all residents. All residents of Denmark are assigned a unique personal identification number at birth or immigration, which is used for all

health contacts. This number permits unambiguous linkage between healthcare administrative registries [8]. Data were linked to data from the Danish National Patient Registry [9]. Appropriate diagnostic packages were defined as an acceptable standard and defined by a Delphi method based on the patient discharge diagnosis (from in-hospital care), see below.

Variables

The analysis was based on data on the following variables: assigned diagnostic package, patient discharge diagnosis, hospital, gender, age, time of admission and discharge, length of stay, diagnostic package assigned, first documented discharge diagnosis, last documented discharge diagnosis (at hospital) according to the International Classification of Diseases (ICD)-10 index, and co-morbidity (Charlson Comorbidity Index) [10].

Acceptable standard procedure

We defined which diagnostic packages offered acceptable handling of patients who ended up with specific ICD-10 discharge diagnoses and used this as our acceptable standard.

As an example, a patient who ends up being discharged with pneumonia could be assumed to have received acceptable primarily diagnostic actions if a *fever or dyspnoea* package had been assigned, while a range

of other packages such as *trauma of extremity or psychosis* would not have produced primarily acceptable diagnostic actions. Four of the authors are physicians, who work with acute patients and are specialists in internal medicine, infectious diseases or cardiology, while the fifth author is a specialist in nursing.
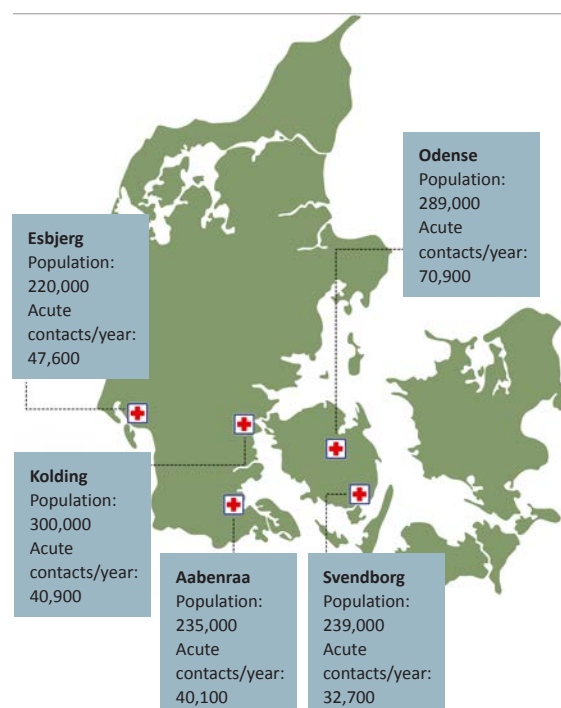
The acceptable standard was developed in a three-step modified Delphi procedure [11] in which:

- A list of all discharge diagnoses given in the inclusion period (n = 2,067) and of the diagnostic packages assigned (n = 40) was generated.
- Each of the five authors indicated which of the diagnostic packages would, in their opinion, have offered relevant primarily diagnostic actions for a patient with the given discharge diagnosis. More than one diagnostic package could be suggested. Project members were blinded to information about the other members' choices.
- Association between a discharge diagnosis and a diagnostic package was established when a minimum of three project members considered that a package was an acceptable choice for the diagnosis.

Each project member performed 4,304 such associations. For 85% of the cases, the association was considered acceptable by at least three, or inappropriate by five members. In the remaining 15% of associations, we discussed until a consensus was achieved (details can be obtained from the corresponding author).

Analyses

Age and length of stay are presented as medians (interquartile range (IQR)) and results concerning diagnostic packages are given as proportions (95% confidence interval (CI) based on a binominal distribution) as appropriate. Given our expectation that patients' chance of being assigned an acceptable diagnostic package would decrease with the complexity of their complaint and the duration of their admission, analyses were stratified by length of stay and co-morbidity (Charlson Comorbidity Index). All analyses were performed using Stata 13 software (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

Ethical considerations

The study was considered a quality assurance project and was approved by the heads of the EDs, the hospital managements and by the Regional Council. No ethical approval was required. The study was registered with the Danish Data Protection Agency (No. 2008-58-0035).

Trial registration: The study was registered with the

The five emergency departments in Region of Southern Denmark.

Odense
Population: 289,000
Acute contacts/year: 70,900

Esbjerg
Population: 220,000
Acute contacts/year: 47,600

Kolding
Population: 300,000
Acute contacts/year: 40,900

Aabenraa
Population: 235,000
Acute contacts/year: 40,100

Svendborg
Population: 239,000
Acute contacts/year: 32,700

Danish Data Protection Agency (No. 2008-58-0035). No further approval was required.

RESULTS

Population and distribution of diagnostic packages

We identified 17,694 patient contacts that had been assigned to a diagnostic package in the inclusion period. A total of 17,531 of these contacts were validated as unique patient pathways. Cases involving redundant contacts within 24 hours (n = 141) were excluded as it is not possible to separate cases of readmission within 24 hours. Likewise, children younger than 15 years of age (n = 288) (the diagnostic packages were not designed for children) were excluded, leaving a sample of 17,102 cases for descriptive analysis. Of these, 16,543 (96.7%) were identified in the Danish National Patient Registry, enabling validation for the key analyses concerning co-morbidity and association between assignments to diagnostic packages and discharge diagnoses (**Figure 2**).

Women constituted 52.2% (n = 8,925) of the included patients. The median age was 64 years (IQR: 44-77) and the median in-hospital length of stay was one day (IQR: 0-4).

The number of different discharge diagnoses used by EDs was 1.8; the corresponding number for hospital discharge was 2.0. All of the 40 described diagnostic packages were represented. *Abdominal pain* was the most frequently assigned diagnostic package (21%), followed by *airway symptoms* (11%), *neurologic disorder and chest pain* (both 6%) (**Table 1**); 80% of all included patients (13,880) were covered by 14 diagnostic packages.

### Association between discharge diagnoses and diagnostic packages

A total of 68% of the included patients had been assigned an acceptable diagnostic package (95% CI: 67.2-68.7). We found appropriate use of packages in more than 50% of cases in 30 diagnostic packages (**Table 2**). The analysis of the appropriateness of the diagnostic packages assigned found a 100% fit for the package *uncooperative patient;* however, this was used only four times. Among the more frequently used packages, appropriate choices were made in 84.7% of extremity *trauma cases* (n = 366), 82.4% of *surgical abscess* (n = 329) cases and 80.8% of *airway symptom* (n = 1,831) cases.

Age group, hospital, length of stay and co-morbidity

We found significant associations between age and assignment to an acceptable diagnostic package; younger patients were more likely than elderly patients to be offered an acceptable package (p < 0.001).

FIGURE 2

Flow chart showing the total population and excluded and included contacts.
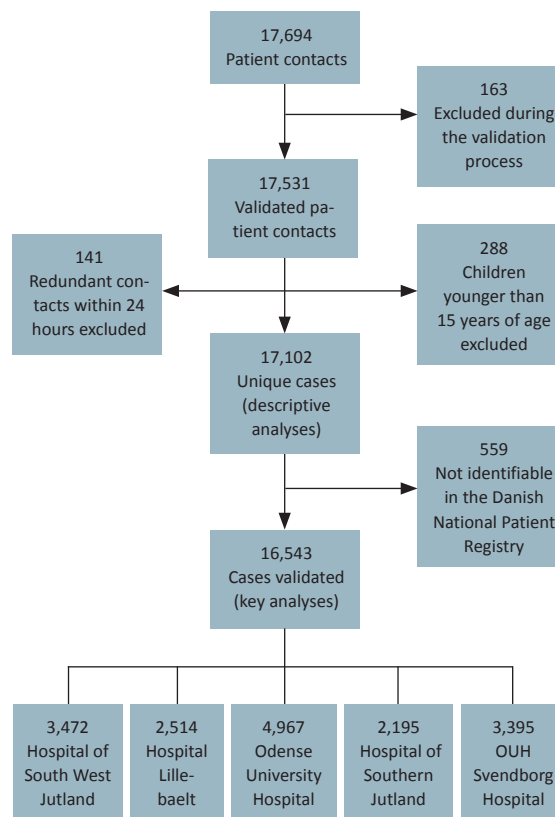
OUH = Odense University Hospital.

Where length of stay was 2-5 days, significantly more patients were assigned an acceptable diagnostic package compared with shorter or longer stays (p < 0.001). The studied hospitals showed no significant differences with respect to their success in assigning patients to acceptable pathways.

No co-morbidity was found in 47.7% of the included cases, whereas 31.5% were classified as 1-2 and 20.7% were classified as greater than or equal to 3 on the Charlson Comorbidity Index. We found no significant association between co-morbidity and assignment to an acceptable diagnostic package.

DISCUSSION

We found that all diagnostic packages were used, and approximately 80% of all acute pathways were covered by only 14 packages. Around 68% of the included patients were assigned an acceptable diagnostic package, significantly more among younger patients and when the length of stay was 2-5 days.

Abdominal pain was the most frequently assigned diagnostic package (21%), followed by *airway symptoms*

TABLE 1

Distribution of diagnostic packages, by hospital. In order of frequency.

Diagnostic package: chief complaint	Hospital, n (%)					Total, n (% [accumulated])
	Esbjerg	Kolding	Odense	Svendborg	Aabenraa	
Abdominal pain	628 (17)	659 (23)	936 (19)	632 (18)	716 (32)	3,571 (20.9 [20.9])
Airway symptoms	396 (11)	100 (4)	757 (15)	412 (12)	189 (8)	1,854 (10.8 [31.7])
Neurologic disorder	383 (11)	18 (1)	414 (8)	252 (7)	11 (0)	1,078 (6.3 [38.0])
Unspecific illness	180 (5)	186 (7)	127 (3)	380 (11)	171 (8)	1,044 (6.1 [44.1])
Chest pain	353 (10)	226 (8)	278 (6)	140 (4)	35 (2)	1,032 (6.0 [50.2])
Fever	215 (6)	265 (9)	314 (6)	140 (4)	73 (3)	1,007 (5.9 [56.1])
Pain in extremity	193 (5)	201 (7)	172 (3)	175 (5)	109 (5)	850 (5.0 [61.0])
Other laboratory deviances	100 (3)	46 (2)	189 (4)	132 (4)	74 (3)	541 (3.2 [64.2])
Faint	71 (2)	82 (3)	269 (5)	63 (2)	49 (2)	534 (3.1 [67.3])
Pain and symptoms from urinary tract	104 (3)	14 (0)	189 (4)	123 (4)	13 (1)	443 (2.6 [69.9])
Gastrointestinal bleeding, upper	83 (2)	61 (2)	87 (2)	66 (2)	137 (6)	434 (2.5 [72.4])
Poisoning	74 (2)	83 (3)	157 (3)	57 (2)	48 (2)	419 (2.5 [74.9])
Extremity trauma	9 (0)	129 (5)	15 (0)	103 (3)	123 (6)	379 (2.2 [77.1])
Unconsciousness	55 (2)	54 (2)	156 (3)	52 (2)	42 (2)	359 (2.1 [79.2])
Surgical abscess	62 (2)	61 (2)	70 (1)	74 (2)	68 (3)	335 (2.0 [81.2])
Cardiac dyspnoea	165 (5)	54 (2)	34 (1)	53 (2)	25 (1)	331 (1.9 [83.1])
Palpitation	116 (3)	102 (4)	61 (1)	28 (1)	6 (0)	313 (1.8 [84.9])
Hip pain	5 (0)	73 (3)	17 (0)	89 (3)	96 (4)	280 (1.6 [86.6])
Headache	54 (2)	30 (1)	126 (2)	52 (2)	16 (1)	278 (1.6 [88.2])
Convulsions	45 (1)	43 (2)	126 (2)	37 (1)	18 (1)	269 (1.6 [89.8])
Dizziness	48 (1)	46 (2)	119 (2)	29 (1)	22 (1)	264 (1.5 [91.3])
Diarrhoea or/and vomiting	72 (2)	61 (2)	46 (1)	60 (2)	17 (1)	256 (1.5 [92.8])
Glucose deviances	35 (1)	28 (1)	80 (2)	55 (2)	34 (2)	232 (1.4 [94.2])
Pain in back and loin	11 (0)	33 (1)	101 (2)	41 (1)	38 (2)	224 (1.3 [95.5])
Allergy/anaphylaxis	33 (1)	26 (1)	61 (1)	29 (1)	9 (0)	158 (0.9 [96.4])
Head trauma	4 (0)	33 (1)	11 (0)	33 (1)	23 (1)	104 (0.6 [97.0])
Gastrointestinal bleeding, lower	12 (0)	41 (1)	6 (0)	35 (1)	1 (0)	95 (0.6 [97.6])
High blood pressure	26 (1)	14 (0)	17 (0)	21 (1)	15 (1)	93 (0.5 [98.1])
Peripheral oedema	15 (0)	1 (0)	32 (1)	6 (0)	9 (0)	63 (0.4 [98.5])
Swallowing difficulties	2 (0)	9 (0)	14 (0)	10 (0)	17 (1)	52 (0.3 [98.8])
Wounds	3 (0)	14 (0)	4 (0)	15 (0)	13 (1)	49 (0.3 [99.1])
Pain in scrotum	12 (0)	4 (0)	24 (0)	2 (0)	1 (0)	43 (0.3 [99.3])
Falling	4 (0)	8 (0)	12 (0)	15 (0)	4 (0)	43 (0.3 [99.6])
Suicidality or self-harming	12 (0)	1 (0)	3 (0)	4 (0)	2 (0)	22 (0.1 [99.7])
Thorax trauma	1 (0)	4 (0)	7 (0)	3 (0)	3 (0)	18 (0.1 [99.8])
Delirium	3 (0)	0 (0)	6 (0)	0 (0)	0 (0)	9 (0.1 [99.8])
Cardiac arrest	0 (0)	5 (0)	4 (0)	0 (0)	0 (0)	9 (0.1 [99.9])
Abstinence	5 (0)	0 (0)	3 (0)	0 (0)	0 (0)	8 (0.0 [99.9])
Uncooperative patient	1 (0)	1 (0)	3 (0)	0 (0)	0 (0)	5 (0.0 [100.0])
Acute psychosis	1 (0)	2 (0)	1 (0)	0 (0)	0 (0)	4 (0.0 [100.0])

(11%), *neurologic disorder and chest pain* (both 6%). Our findings hence partly corroborate those of an American study in which *abdominal pain, chest pain* and *breathing difficulties* were among the five most commonly coded chief complaints [12]. Furthermore, in a Finnish study classifying 89 complaint categories, the authors found that 7.6% concerned *abdominal pain*, 3.7% *chest pain* and 4.9% *airway symptoms* [13]; a Danish study assessing the pathway of 9,863 acute patients showed that 20% were assigned to packages for *abdominal pain*, 6% for *chest pain* and 7% for airway symptoms [7]. Others

[14] found a 86% correlation between discharge diagnoses and medical assessment practice in a Scandinavian material. Thus, our result may represent an underestimation.

Some of the 40 described diagnostic packages were used infrequently (25 < 2%, of those 16 < 1%) and 79% of the in-hospital admissions were assigned to the 14 most frequently used diagnostic packages. This corroborates the conclusion of the aforementioned study, which shows that 75% of all acute admissions are covered by a mere 12 complaint categories [7].

TABLE 2

Number and proportion of acceptable diagnostic packages. In order of acceptability.

Diagnostic package	Assigned to package, n	Acceptable packages, n (% [95% CI])
Uncooperative patient	4	4 (100.0 [-])
Extremity trauma	366	310 (84.7 [80.6-88.0])
Surgical abscess	329	271 (82.4 [77.8-86.1])
Airway symptoms	1,831	1,480 (80.8 [79.0-82.6])
Abdominal pain	3,400	2,705 (79.6 [78.2-80.9])
Poisoning	410	324 (79.0 [74.8-82.7])
Pain in back and loin	218	168 (77.1 [71.0-82.2])
Pain and symptoms from urinary tract	434	330 (76.0 [71.8-79.8])
Glucose deviation	229	172 (75.1 [69.1-80.3])
Fever	975	709 (72.8 [69.8-75.3])
Pain in scrotum	40	29 (72.5 [56.1-84.5])
Chest pain	1,003	708 (70.6 [67.7-73.3])
Convulsions	266	186 (69.9 [64.1-75.2])
Gastrointestinal bleeding, lower	86	60 (69.8 [59.1-78.7])
Allergy/anaphylaxis	153	105 (68.6 [60.8-75.4])
Hip pain	277	187 (67.5 [61.7-72.8])
Acute psychosis	3	2 (66.7 [0.3-99.9])
Neurologic disorder	1,067	703 (65.9 [63.0-68.7])
Head trauma	1	67 (65.7 [55.8-74.4])
Headache	274	180 (65.7 [59.8-71.1])
Swallowing disturbances	50	32 (64.0 [49.4-76.4])
Abstinence	8	5 (62.5 [20.8-91.3])
Fainting	522	306 (58.6 [54.3-62.8])
Palpitation	301	172 (57.1 [51.5-62.7])
Pain in extremity	781	443 (56.7 [53.2-60.2])
Gastrointestinal bleeding, upper	428	239 (55.8 [51.1-60.5])
Wounds	49	27 (55.1 [40.6-68.7])
Unspecific illness	1,008	540 (53.5 [50.4-56.5])
Diarrhoea or/and vomiting	243	122 (50.2 [43.9-56.6])
Suicidality or self-harming	22	11 (50.0 [28.7-71.3])
High blood pressure	89	44 (49.4 [39.0-59.9])
Thorax trauma	17	8 (47.1 [23.5-72.0])
Dizziness	257	115 (44.8 [38.7-50.9])
Cardiac arrest	9	4 (44.4 [13.4-80.5])
Other laboratory deviances	522	230 (44.1 [39.8-48.4])
Cardiac dyspnoea	319	116 (36.4 [31.2-41.8])
Peripheral oedema	50	17 (34.0 [21.9-48.6])
Unconsciousness	349	104 (29.8 [25.2-35.8])
Delirium	9	2 (22.2 [3.9-67.0])
Falling	43	7 (16.3 [7.7-31.1])

CI = confidence interval.

Our findings have organisational and clinical implications. We have shown that it is possible to describe a number of diagnostic packages which can be used in the ED and lead to correct diagnoses. The most frequently used diagnostic packages had a high proportion of appropriateness, except for the package *unspecified illness.* However, several of the packages were used infrequently, and the number of packages should be reconsidered.

Some of the packages might be important to keep, even if they are rarely used as they describe the diagnostic processes of life- or limb-threatening conditions.

Our results are limited by certain factors. We used discharge diagnosis as a basis for the acceptable standard defining an appropriate primarily diagnostic package. A number of the discharge diagnoses may have been inadequate, too general or too unspecific to enable a reasonably safe assessment in our acceptable standard procedure. The result may therefore be that we failed to identify an acceptable pathway. Further investigation this question would require an audit of patient records.

We categorised acceptable assignments to specific patient pathways based solely on our assessment of the association between discharge diagnosis and the primarily diagnostic packages. The primarily diagnostic packages are suggestions to the clinicians, and it was not ascertained whether the diagnostic actions recommended in the chosen package were actually performed or to which degree the diagnostic package provided extra information to the clinician or extra quality to the patients compared with the previous, less structured, clinical standard.

CONCLUSIONS

We found that 68% of the included patients were assigned an acceptable diagnostic package, and that about 80% of all acute pathways were covered by 14 diagnostic packages.

The diagnostic packages showing the highest proportion related to relevant discharge diagnoses are *trauma of extremity, surgical abscess, airway symptoms, abdominal pain, poisoning, pain in back and loins, pain and symptoms from urinary tract* and *blood glucose deviances*, all of which recorded more than 75% match between discharge diagnoses and diagnostic package.

We suggest that the concept of acute diagnostic packages be further refined and tested.

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