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Unexpected Deaths in the Hospital: A Twelve Year Retrospective Review in a Belgian University Hospital

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Abstract

Aims and objectives: To study the prevalence, characteristics and circumstances of unexpected in-ward deaths in a Belgian university hospital, in order to delineate future prevention strategy.

Methods: Twelve year review. Unexpected in-ward deaths were listed from a local questionnaire (database) on the characteristics and circumstances of each in-hospital death. Comparison of variables was made with expected deaths. Medical and nursing notes of patients who died unexpectedly were then reviewed, with particular attention to the premonitory signs (abnormal physiological parameters or presumed risk factors) that were possibly documented in the 48 hours preceeding death.

Results: Unexpected deaths accounted for 8,3 % (n= 221) of total in-ward deaths. These deaths did not occur preferentially to specific days of the week, but occurred more often during night-time, with a peak in the early morning. In only 9 (4%) cases (p< 0,001 vs expected deaths), the family was present at the bedside of the patient at the time of his death. Relative prevalence of unexpected deaths was higher in surgical wards, and most (63%) unexpected death patients had been admitted through Emergency room ; 24.4% had a prior stay in Intensive Care Unit and 35.7% underwent an invasive procedure during their hospitalisation. Identification of a presumed risk factor or detection of abnormal vital signs before death were found in 166 (75,1%) patients; only 49 of these had a written advance care plan found in their file notes.

Conclusion: Prevalence of unexpected in-ward deaths is substantial and requires preventive measures. Most patients dying unexpectedly had presented early warning signs within the 48 hours before fatal event. Based on our observations, reinforcing the night staffing of units that admit patients with an acute morbidity profile would be wise. Also, implementing a systematic approach (algorithms) of the acutely deteriorating patients with timely initiation of end-of-life discussions seems essential.

Introduction

Patients admitted to hospital are expected to stay in a safe environment. If acute deterioration does occur, it is thus expected that symptoms of deterioration will be promptly recognized for immediate and effective treatment to ensue.

Despite efforts being made by hospitals to improve early detection and proper management of acutely deteriorating patients, there is evidence however that a significant number of unexpected in-hospital deaths still occur. Therefore, strategies have been proposed in the last decades to prevent unexpected in-hospital deaths, including rapid rescue teams and various education systems [1-4]. The effectiveness of a given strategy must logically depend on the processes of care already set in each hospital. A thorough analysis of unexpected deaths in a given hospital may thus be valuable when new processes are to be implemented in a cost containment environment.

In order to define the best prevention strategy in our hospital,

we analyzed the epidemiology of unexpected deaths that occurred in our center (university hospital-450 beds) over a 12 years period of time (2005-2016). We took a special attention to the timing, the circumstances and characteristics of unexpected in-wards deaths, as well as alert signs that could have been present in the 48 hours preceeding the fatal issue.

Materials and Methods

Hospital main characteristics

Our center is a 420 beds university hospital in Belgium accounting for about 23,000 yearly admissions. It includes 30 intensive care beds (around 1,800 yearly admissions) ; 179 beds designated for medicine (Cardiology (38), Pneumology (54), Oncology (14), Hematology (27), Gastroenterology (27), General internal medicine & Endocrinology (19), Neurology (14)) ; 123 beds designated for surgery (Cardiothoracic & vascular surgery (37), Orthopaedic surgery (17), Urology (12), Neurosurgery (15), General/digestive surgery (25), ENT surgery (17)); 18 beds designated for Rehabilitation and 27 beds designated for Geriatrics. About 5000 patients (22% of total admissions) are yearly admitted via the Emergency room. Nursing cover on the general wards is at an approximate staff to bed ratio of 1:5 to 1:7. During the night-time, staff to bed ratio decreases to 1:16. Night medical coverage in the ward is provided by junior doctors (specializing for surgery or internal medicine), supervised by a senior staff from each specialty. Presently, the hospital is not provided with a rapid rescue team for assisting the doctors or nurses on the floor. However, our traditional « Code » team (composed of an ICU fellow with 2 ICU nurses) is often called preemptively to manage acutely deteriorating in-ward patients before cardiac or respiratory arrest to occur, and ward teams are constantly encouraged to seek assistance from senior intensivists for those patients whose clinical condition is deteriorating.

Data collection

As a local routine procedure, each death occuring in the ward is systematically reported by the attending medical team to the local « Quality & Patient Safety » cell. This is done via a questionnaire that inquires into the circumstances (focusing mainly on sentinel diagnostic indicators), causes (presumed or proven) and various characteristics of each death. As part of the questionnaire, the attending team is also asked to categorize each single death as « expected » or « unexpected », with the following definition for unexpected death: « a death that is not expected to occur at that time and/or under these circumstances».

Comparison « expected versus unexpected deaths »

In a first stage of this work, basic demographic data and reported variables of all patients dying in the hospital from january 1st 2005 to december 31st 2016 were extracted from the database. After exclusion of deaths that occurred in the Emergency and Intensive Care departments or during an invasive procedure (surgery, endoscopy or radiology procedure), a comparison was made between the two groups (expected *vs* unexpected ward deaths) on the following variables: demography, lenght of hospital stay before death, medical specialty of belonging, presence of nurses or relatives at the bedside at the time of death, and documentation of one of the four following sentinel diagnostic indicator : pulmonary embolism- death resulting from infection- death from neoplasia - death resulting from a complicated invasive procedure.

Characterisation of unexpected deaths

Proceeding further to characterisation of unexpected deaths, additional data from unexpected in-ward death patients were collected. These include: day (of the week) and time (hour) of death; presumed or proven cause of death; itinerary of the patient within the hospital prior to death (previous emergency admission-passage to operating room- stay in intensive care) ; and the premonitory signs (abnormal physiological parameters indicating acute deterioration) or presumed risk factors that were possibly documented in the 48 hours preceding death. For this purpose, patient electronic case records (medical and nursing notes) and bedside physiological observation charts were systematically reviewed independently by two of us (BM and JP). Individual data were entered into a computerized database, after reconciliation interview for equivocal data.

Positive premonitory signs were defined as the presence of at least one of the following physiologic abnormalities recorded within the 48 hours prior to death: hypotension (systolic blood pressure <90 mmHg); tachycardia or bradycardia (heart rate: >130 or <50 per minute); respiratory distress (Oxygen desaturation (SaO2 < 90% on plethysmography) or polypnea (respiratory rate > 30 per minute)). The presence of one of the presumed following risk factors was also sought (written documentation in patient's notes): 1) confusion - 2) agitation requiring contention - 3) unability to call the nurse team by him/her self - 4) unability to clear respiratory secretions by him/her self, as reflected by the need for oro-pharyngeal or endotracheal aspiration.

Ethical considerations

The study was conducted in agreement with local ethical rules, and in accordance with the revised (2000) Helsinski declaration. Patient's data were anonymized.

Statistical analysis

Categorical variables were compared by chi-square test. Numerical ones are expressed as median with interquartile range into brackets and were compared by wilcoxon rank sum test.

Results

A total of 4491 patients died during the study period, representing

1.66 % of total inhospital admissions. Of these, 2651 deaths occurred in the ward (exclusion of deaths in the Emergency room, in the Intensive Care unit, and during an invasive procedure), among which 221 deaths (8,3 % of total in-ward deaths) were classified « unexpected » after exclusion of patients with a documented (written) « do not resuscitate » order in medical notes (n=106).

Unexpected versus expected deaths

Analysis of in-ward deaths demonstrated no difference in age and gender between unexpected and expected deaths. Lenght of hospital stay before death was slightly shorter in the « unexpected » group, and the relatives were present at the bedside in only 9/221 (4%) instances (p< 0,001 *vs* expected deaths) (Table 1).

(Total deaths: n= 2651)	**Expected (n= 2430)**	**Unexpected (n=221)**	**p value ( )**
Gender: number of males (%)	1415 (58.2)	136 (61.5)	NS
Age (years): median (interquartile range)	77 (65 ; 84)	76 (66 ;83)	NS
Lenght of stay (days): median (interquartile range)	12 (6 ; 24)	6 (3 ;16)	P<0,001
Family present (%)	1303 (53.6)	9 (4.1)	P<0,001
Sentinel diagnostic indicators:			
°Pulmonary embolism (%)	46 (1.9)	16 (7.2)	P<0,001
°Major Infection (%)	855 (35.2)	46 (20.8)	P=0,001
°Complicated invasive procedure (%)	38 (1,6)	21 (9.5)	p>0,001
°Neoplasia (%)	1056 (43.5)	39 (17.6)	P<0,001

Table 1: Analysis of deaths.

Regarding the sentinel diagnostic indicators, pulmonary embolism and complications of a technical procedure were more often found in unexpected deaths, while cancer and infectious complications were less frequent.

When comparison was made between surgical and medical wards, the relative incidence of unexpected deaths was higher in the surgical wards (72/268 (26,9%) as compared to medical wards (116/1730 (6,7%); p< 0,001)), with marked differences however between different specialties (Table 2).

Units	**Total deaths (n=)**	**Expected deaths (n=)**	**Unexpected deaths (n=)**	**Unexpected deaths/total (%)**
Medical Units (total)	**1730**	**1614**	**116**	**6.7%**
Cardiology	159	129	30	18.9 %
Gastroenterology	120	111	9	7.5 %
Hematology	283	273	10	3.5 %
General internal medicine	63	49	14	22.2 %

Neurology	171	168	3	1.8%
Oncology	396	384	12	3.0%
Pneumology	538	500	38	7.1%
Surgical Units (total)	**268**	**196**	**72**	**26.9%**
Cardiovascular surgery	92	61	31	33.7 %
General surgery	62	44	18	29.0 %
Neurosurgery	67	61	6	9,0 %
ENT surgery	26	22	4	15.4 %
Orthopaedic surgery	14	5	9	64.3 %
Urology	7	3	4	57.1%
Others	**642**	**610**	**32**	**5.0%**
Rehabiliation unit	13	6	7	53.8%
Geriatrics	629	604	25	4.0%

Table 2: Analysis of unexpected deaths.

Characteristics of unexpected deaths

Unexpected in-ward deaths did not occur preferentially to specific days of the week; absolute number of deaths from monday to sunday were respectively: 30-30-30-37-30-34-30. By contrast, unexpected deaths occurred more often during the night-time, with a peak of unexpected deaths observed in the early morning; thus, 34 out of 221 unexpected deaths occurred between 6:00 and 8:00 a.m. (Figure 1).

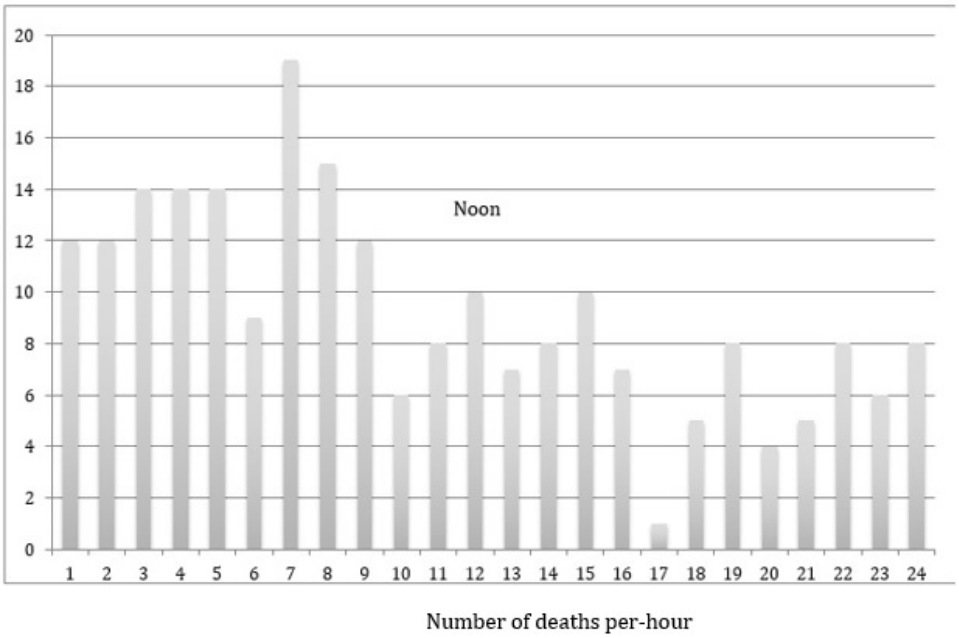

Figure 1: Circadian distribution of unexpected deaths (n=221) by 1-hour interval.

Most (n= 139/221; 62,9%) of the unexpected death patients were admitted via the Emergency room. 54/221 (24,4%) had a previous stay in the Intensive Care Unit, and 79/221 (35,8%) underwent an invasive (surgical or radiological) procedure during their hospitalisation.

Among the 139 patients who died after Emergency room admission, 19 (13,7%) died within the 24 hours and 46 (33,1%) died within the 3 days after their transfer to the ward.

Among the 79 patients who died in the course of an invasive procedure, 16 patients (20,2%) died within the 24 hours and 27 (34,2%) died within the 3 days after the procedure.

Eighty five deaths (37,8%) followed failed attempts of resuscitation. In 28,2% (n= 52/221) of the unexpected in-ward deaths, a written advance care plan (advising for no restriction of therapy) was documented in the medical notes.

Premonitory signs before unexpected death

Abnormal vital signs were documented within the 48 hours preceeding death in 144 out of 221 patients (65,2%), while 69 (31,2%) patients had one or more presumed risk factor present. In total, presence of a presumed risk factor or detection of abnormal vital signs in the previous 48 hours were found in 166 out of 221 (75,1%) patients. Only 49 (22,1 %) of these high risk patients had a written advance care plan found in their file notes. Details on separate abnormalities of vital parameters and presupposed risk factors are provided in table 3.

Abnormal Vital Signs	**Patients** **144/221 (65,2%)**
Blood pressure <90mmHg	36
Heart rate >130/min	10
Heart rate<50/Min	2
Oxygen saturation <90%	77
Respiratory rate >30/min	96
Presumed Risks factors	**Patients** **60/221 (31,2%)**
Confusion	37
Agitation requiring contention	3
Inability to call Nurse	21
Need for pharyngeal aspiration	15
Total	**166/221 (75,1%)**

Table 3: Abnormal Vital Signs.

Discussion

This study seems to be the first that explicitly examines unexpected hospital deaths. It shows that a significant number of in-hospital deaths are unexpected as about 5% of total in-hospital deaths (and about 8% of total in-ward hospital deaths) were considered as such by the attending medical teams after exclusion of patients with DNR orders.

Few data are available in the literature on the prevalence of unexpected deaths in general hospitals. In a six-month audit performed in a british teaching hospital in 1999, Mc Gloin reported that 6% of deaths occurring in general wards were unexpected [5]. In a trauma center, unexpected non ICU ward deaths accounted to 2.4% of hospital mortalities over a 10 year period [6]. The comparison between studies is difficult however, due to different definition criteria and because of a different case mix between hospitals.

Beyond the legitimate questions about the quality of care, unexpected death undeniably impacts the families and attending teams emotionally; due to the suddenness of the event, it generates intense moral pain with families that are often absent at the time of death and can't comfort their loved one during his/her end of live. In our study, the relatives were indeed present with the dying patient in only 4% of the cases.

Our study contributes to better understanding the profile of patients at risk of unexpected in-hospital deaths. Not surprisingly, most of the these patients already demonstrated an acute morbidity profile well before the clinical deterioration. A large majority of unexpected death patients were indeed initially admitted via the Emergency department, more than a third underwent an invasive procedure during their hospital stay, and about a fourth had experienced an ICU stay preceding in-ward death. In a consistent way, the proportion of unexpected deaths was higher in the surgical units. The acute morbidity profile of unexpected in-ward deaths is also reflected by the higher incidence of patients having experienced either a pulmonary embolism or a complicated invasive procedure during their hospitalization.

With respect to the moment, a peak of unexpected death was observed during night-time and early morning, while the 24 hours

period after an emergency room admission or after an invasive procedure seemed to be at particular risk. A circadian pattern that favoured the early-morning hours for the onset of unexpected in-hospital cardiopulmonary arrests has already been demonstrated by Buff et al. [7]. Although possibly corresponding to a circadian pattern of some acute diseases (ischemic events preferentially occurring at night), it also raises questions on the adequacy of monitoring and treatment levels during night-time. Similar to our findings, in-ward patients recently admitted from the emergency room [8], or transferred from the intensive care units [9], were targeted as a population at risk in previous studies, a large number of acute unexpected events occurring in these within the 24 h of transfer. Thus, increasing the nurse staffing during night-time in the surgical wards and units that receive acute patients from emergency room may constitute a sound decision to lower the rate of unexpected deaths in our hospital.

Most cases of unexpected deaths in our study were preceded by clinically observable warning signs. Abnormal vital signs were indeed frequently documented in the 48 hours before fatality, and there was therefore enough time to react and deliver appropriate intervention. Thus, optimization of the response to alert signs is probably a further major point of improvement toward which we should direct our efforts.

Unexpected deaths, unplanned ICU admissions and cardiopulmonary arrests may all result from a common phenomenon, namely a delayed or inadequate response to clinical deterioration [10,11]. A number of retrospective studies focused on physiologic abnormalities that were present in general ward patients prior to cardiac arrest [12-14], or unplanned ICU admission [12,15-17]. Similar to our findings, the authors highlighted the frequency of premonitory signs that were recognised but not acted on. Suboptimal reaction to the premonitory signs may come from a number of factors including underestimation of the severity of symptoms by the nurses with failure to seek advice and inadequate clinical assessment of the patients by the medical teams [2,10,11]. Smith demonstrated indeed that many trainee doctors have a poor understanding of acute illness that impedes their ability to identify deterioration and to treat acutely ill ward patients effectively [18].

Given our findings, several measures should be considered to decrease the proportion of unexpected deaths in our hospital. Better education of in-ward teams in the recognition and understanding of early warning signs would be eminently useful. In this regard, implementation of algorithms for the management of the acutety deteriorating in-ward patient should help to clarify the respective role of nurse and medical teams. The expansion of the duties of our code team to include systematic assessment of patients who fulfill predefined criteria should also be considered. In addition to the awaited benefit on early management of deteriorating patients, this may help in-ward teams in decision making about end-of-life care; indeed, only a minority of our unexpected deaths with premonitory signs had a written advance care plan (advising for no restriction of therapy), and it is most likely that some of these patients would not have been eligible for full therapy if an end-of-life discussion had been committed.

Rapid response teams have been implemented in many countries (mainly North America, Scandinavia, UK, New Zeeland and Australia) to improve the safety of hospital patients whose condition is deteriorating. These systems rely on the identification of patients at risk on the basis of predefined criteria (« early warning signs »), early notification, then rapid intervention by a specialized team often led by a critical care physician or fellow [11,19]. Whether rapid-response systems are effective remains however controversial. Initial single-center studies [20-24], showed a reduction in the rate of cardiac arrests and unplanned ICU admissions, but a large multicenter controlled trial (MERIT study) [25] and two meta-analyses [26,27], failed to confirm the benefit. Cost of rapid-response systems implementation should also be considered [28].

Our study has a number of potential limitations. First, the data came from a single hospital, and our conclusions may not apply to other centers. Secondly, the criteria we used for definition of « unexpected » death were based on the subjective appreciation of the attending teams. Since teams may assess differently a similar situation, a comparison of the prevalence of unexpected deaths between different specialties is fragile. Also, retrieved data were dependent upon the quality of note-keeping, and therefore documentation of some abnormal vital parameters or presumed risk factors may have been missing. Similarly, abnormal biochemical data that may constitute additional alert signs were not searched. These findings however would have further increased the proportion of unexpected death patients with premonitory signs documented before death.

Conclusion

We demonstrated that unexpected in-ward deaths accounted to about 5% of total in-hospital deaths (and to about 8% of total in-ward deaths) in our belgian hospital center. Most of these were preceeded by early warning signs, and might thus have been potentially preventable. Analysis of circumstances and timing of unexpected deaths should guide decisions about our future prevention strategies. In this hospital, a special attention should be paid to the night staffing of units admitting patients with an acute morbidity profile (patients transferred from emergency room, patients with a prior ICU stay, surgical patients). A systematic approach (algorithms) of the acutely deteriorating in-ward patients with clarification on the role of each caregiver and timely initiation of end-of-life discussions must be developed and taught.

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