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A hospital incident reporting system (2016–2019): Learning from notifier's perception on incidents' risk, severity and frequency of adverse events

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Patient safety;
Incident reporting system

Abstract Incident reporting systems (IRSs) are considered safety culture promoters. Nevertheless, they have not been contemplated to monitor professionals' perception about patient safety related risks. This study aims to describe the characteristics and evolution of incident notifications reported between 2016 and 2019 in a high complexity reference hospital in Barcelona and explores the association between notifications' characteristics and notifier's perception about incidents severity, probability of occurrence and risk. The main analysis unit was notifications reported. A descriptive analysis was performed and taxes by hospital activity were calculated. Odds ratios were obtained to study the association between the type of incident, the moment of incident, notifiers' professional category, reported incident's severity, probability and incidents' calculated risk. Through the study period, a total of 6379 notifications were reported, observing an annual increase of notifications until 2018. Falls (21.22%), Medical and procedures management (18.91%) and Medication incidents (15.49%) were the most frequently notified. Departments reporting the highest number of notifications were Emergency room and Obstetrics & Gynaecology. Incident type and notifiers' characteristics were consistently included in the models constructed to assess risk perception. Pharmaceutics were the most frequent notifiers when considering the proportion of staff members. Notification patterns can inform professionals' patient risk perception and increase awareness of professionals' misconceptions regarding patient safety.

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PALABRAS CLAVE
Seguridad del paciente;
Sistema de notificación de incidentes

Un sistema de notificación de incidentes hospitalarios (2016-2019): aprendizaje de la percepción de los notificadores sobre el riesgo de los incidentes, la gravedad y la frecuencia de los eventos adversos

Resumen Los sistemas de notificación de incidentes promueven la cultura de la seguridad en los hospitales. Sin embargo, no se han considerado para conocer la percepción de los profesionales sobre los riesgos relacionados con la seguridad del paciente. Este estudio pretende describir las características y la evolución de las notificaciones de incidentes comunicadas entre 2016 y 2019 en un hospital de alta complejidad de Barcelona y explorar la asociación entre las características de las notificaciones y la percepción del notificador sobre la gravedad de los incidentes, la probabilidad de ocurrencia y el riesgo. La unidad de análisis principal fueron las notificaciones comunicadas. Se realizó un análisis descriptivo y se calcularon las tasas en relación con la actividad hospitalaria. Se obtuvieron las *odds ratios* para estudiar la asociación entre el tipo de incidente, el momento del incidente, la categoría profesional de los notificadores, la gravedad, probabilidad y riesgo calculado del incidente. A lo largo del periodo de estudio se registraron un total de 6.379 notificaciones, observándose un incremento anual de notificaciones hasta 2018. Las caídas (21,22%), los problemas en la gestión médica y de procedimientos (18,91%) y los incidentes de medicación (15,49%) fueron los más notificados. Los departamentos que reportaron el mayor número de notificaciones fueron urgencias y obstetricia y ginecología. El tipo de incidente y las características de los notificadores se incluyeron sistemáticamente en los modelos para evaluar la percepción del riesgo. Los farmacéuticos fueron la categoría profesional más notificadora considerando el número de profesionales en plantilla. Los patrones de notificación pueden informar sobre la percepción del riesgo de los pacientes por parte de los profesionales y ayudar a detectar creencias erróneas de los profesionales acerca de la seguridad de los pacientes.

Introduction

Incident reporting systems (IRSs) are key in patient safety developing.[1] The main goal of patient safety is considered to be the prevention of healthcare errors, reduce patient's safety risk and design measures to determine, report and correct the errors before they affect the patient.[2]

IRS aims to identify risks so actions can be implemented to minimize those risks. They allow continuous learning through the analysis of experiences that can compromise clinical safety. This gives the institutions the opportunity to design and implement preventive measures to ensure constant improvement of clinical practice. IRS are barely considered surveillance systems, as normally depend on surveillance awareness and honesty.[2] Moreover, concerns have been raised about the difficult interpretation and comparison of results and their usefulness.[3] However, they are thought to be operatively useful in identifying local hazards, can be used to identify protocol deviances through the collection of uncommon events and repetitive incidents, and have been considered a key part of a safety culture construction.[1,4] Most groups claiming the IRS as safety culture promoter, relate to the fact that the more people notify, the more awareness there would be about patient safety and risks.[5] Nevertheless, considering that IRS functioning depends on notifiers' risk perception, to date, it has not been contemplated as a tool to monitor professionals' perception about patient safety.

Recent reports and studies published with IRS data, refer mostly to the analysis of incidents related to specific health departments[6–10] whereas some general country-level IRS analyses are available and based on hospital-level IRS data collection.[11–13] Moreover, some studies have shown certain repetitive patterns of notification (e.g. doctors notifying incidents considered more severe and nurses notifying more events) in IRS data analysis.[12,14–16]

This study aims to describe the characteristics and evolution of incident notifications reported between 2016 and 2019 in a high complexity reference hospital in Barcelona and explores the association between notifications' characteristics and notifier's perception about incidents severity, probability of occurrence and risk.

Methodology

Study setting

Hospital Clínic is a high complexity reference hospital in Barcelona with a reference population of 540,000 inhabitants.[17] It has 728 beds, and in 2019 reported 44,035 inpatient discharges, 142,823 Emergency room visits and 551,800 ambulatory visits. The hospital's activity is organized in divisions called institutes. Each institute is constituted by related departments – a description of these hospital sections has been described elsewhere.[18] On another note, hospital human resources management is different between professional categories. There are three

different shifts for nurses, auxiliary nurses, wardens and administrative staff – morning, noon and night, with 8 h per shift. While medical professionals can work shifts of 8, 10, 16 or 24 h depending on their professional category.

Patient safety IRSwas piloted in Hospital Clínic de Barcelona (HCB) in 2014 and started its activity in October 2015. The implementation of the IRS led to the construction of multidisciplinary groups of delegates from each institute. These groups are called ''Safety Nuclei'' and they are responsible for analyzing and processing the notifications and for promoting and monitoring the implementation of improvement measures. Safety Nuclei are constituted by an interdisciplinary group of professionals and always include a pharmacist and a Preventive Medicine professional. This study includes notifications reported between 2016 and 2019, excluding the first months of implementation in 2015.

Data source and variables

The main analysis unit was notifications reported to the HCB patient safety IRS. Notification details were collected on The Patient Safety Company® (TPSC) platform.[19] TPSC platform is structured in different sections according to Hospital's institutes,[12] hereinafter referred to as departments. Some platform variables were calculated and recategorized for the analysis.

Independent variables

The platform variables chosen as independent variables were the department where the incident took place, contributing factors related to patient or professionals, people involved in the incident (patient or professionals), way of knowing (Experienced, when the notifier has had a first-hand experience of the incident and has been involved in it, Observed, Heard from Other), professional category (Doctor, Nurse, Assistant Nurse, Medical Residents, Pharmacist, Administrative Staff, Other) and type of incident according to the WHO taxonomy.[20] The variable shift was calculated through the incident hour: 8.01–22.00 h for the first and second shift (day shift) and 22.00–8.00 for the third shift (night shift). Holiday period was defined as a qualitative variable with two categories; holiday period (including the periods from December 23rd to January 7th, Easter holidays in each year and from the 1st of July till 31st of August) and non-holiday period (the rest of the year). Variables including department groups were regrouped in 4 categories: surgical, medical, medical-surgical (otorhinolaryngology, ophthalmology and gynaecology) and Others (anatomopathology, biochemistry, genetics, analysis centre, pharmacy, radiology and nuclear medicine). Non-healthcare provider departments were excluded from the analysis.

Dependent variable

Fig. 1 shows the characteristics of the platform variables included as dependent variables in this analysis. The risk assigned to each incident is calculated through the risk matrix presented on the platform (Fig. 2), which uses the variables ''severity'' and ''probability of occurrence'' for risk assignment (initially both reported by the notifier). The final risk assigned to each notification is the result of a twofold evaluation, the initial evaluation performed by the notifier based on the risk matrix and the subsequent healthcare contextualisation of the incident by the Safety Nuclei. Severity with initially 5 categories (no harm, minor harm, moderate, severe and extreme) was recoded into 3 categories for the analysis: No harm/minor harm, Moderate and Severe. Notifications classified as Extreme risk by the notifier are considered sentinel events. The probability of occurrence was also recoded into 3 categories: Infrequent, Occasional/Probable and Frequent.

Data analysis

A descriptive analysis of the selected variables was performed. Incidents rate per hospital activity was calculated for each department using both the department's total discharges and total days of hospitalization. Taxes were calculated only considering inpatient care. Distribution of the number of notifications per variable was reported in absolute and relative terms and statistical comparison was performed through Chi square test considering all forms of healthcare. In order to compare the number of notifications per professional category, adjusted rates were calculated considering the number of workers for each professional category in 2019. Variables with more than 30% of missing values are excluded. Sentinel events detection was summarized narratively through the identification and classification by cause rout analysis processes.

The odds ratios (OR) with 95% of confidence intervals (95% CI) were calculated to study the association between the type of incident, the moment of incident (shift and holiday season), notifiers characteristics (department and professional category), and reported incident's severity, probability and incidents' calculated risk. To calculate the OR, three ordinal logistic models were built following the Akaike Information Criterion[21] to study the association between notification factors and reported probability of occurrence, severity and risk (hereinafter, model A, B and C respectively). All analyses were made with Stata 15.

Results

During the study period, a total of 6379 notifications were reported. Of these, 1170 (18.34%) were reported in 2016, 1637 (25.66%) in 2017, 1869 (29.30%) in 2018 and 1703 in 2019 (26.70%). Regarding the place where the notified incidents occurred, 3745 (58.71%) belonged to hospitalization episodes, 1212 (19.00%) to emergency episodes, 566 (8.87%) took place in the outpatient care, 492 (7.71%) in surgery, 361 (5.66%) belonged to non-assistance services and 3 (0.05%) were missing.

Considering the inpatient care activity, the Neuroscience and the Obstetrics & Gynaecology department had the highest rate of notifications per 1000 hospital discharges. This doubled other departments' rates such as Orthopaedic Surgery & Rheumatology and Nephrology & Urology. The Obstetrics & Gynaecology department presented the highest notification rate per 1000 days of hospitalization and Cardiology & Cardiac surgery department the lowest. Some departments increased the number of notifications adjusted

Table 1 Notifications per 1000 hospital discharges by department and year. IRS, Hospital Clínic 2016–2019.

Institute	2016	2017	2018	2019	Total
Cardiology & cardiac surgery					
Number of notifications	75	61	62	63	261
Total discharges	4536	4325	4502	4608	17971
Notifications per 1000 hospital discharges	16.5	14.1	13.8	13.7	14.5
Total days of hospitalization	28808	28463	28056	27284	112611
Notifications per 1000 days of hospitalization	2.6	2.1	2.2	2.3	2.3
Orthopaedic Surgery & Rheumatology					
Number of notifications	46	78	54	49	227
Total discharges	5148	5236	5398	4970	20752
Notifications per 1000 hospital discharges	8.9	14.9	10.0	9.9	10.9
Total days of hospitalization	23812	23586	25413	23158	95969
Notifications per 1000 days of hospitalization	1.9	3.3	2.1	2.1	2.4
Obstetrics & Gynaecology					
Number of notifications	167	231	367	253	1018
Total discharges	6927	6727	6636	6527	26817
Notifications per 1000 hospital discharges	24.1	34.3	55.3	38.8	38.0
Total days of hospitalization	24004	23717	23945	20698	92364
Notifications per 1000 days of hospitalization	7.0	9.7	15.3	12.2	11.0
Gastroenterology & Metabolic Diseases					
Number of notifications	88	148	184	228	648
Total discharges	6189	6044	6049	6015	24297
Notifications per 1000 hospital discharges	14.2	24.5	30.4	37.9	26.7
Total days of hospitalization	39043	39343	37468	38113	153967
Notifications per 1000 days of hospitalization	2.3	3.8	4.9	6.0	4.2
Oncology & Haematology					
Number of notifications	52	91	66	82	291
Total discharges	2219	2172	2234	2413	9038
Notifications per 1000 hospital discharges	23.4	41.9	29.5	34.0	32.2
Total days of hospitalization	22753	23481	23901	26230	96365
Notifications per 1000 days of hospitalization	2.3	3.9	2.8	3.1	3.0
Internal Medicine & Infectious Diseases					
Number of notifications	69	114	104	103	390
Total discharges	2981	3374	3283	3682	13320
Notifications per 1000 hospital discharges	23.1	33.8	31.7	28.0	29.3
Total days of hospitalization	2786	30092	29386	33169	95433
Notifications per 1000 days of hospitalization	24.8	3.8	3.5	3.1	4.1
Neurosciences					
Number of notifications	76	139	145	116	476
Total discharges	2912	2931	2916	2889	11648
Notifications per 1000 hospital discharges	26.1	47.4	49.7	40.2	40.9
Total days of hospitalization	30548	30884	31251	31611	124294
Notifications per 1000 days of hospitalization	2.5	4.5	4.6	3.7	3.8
Nephrology & Urology					
Number of notifications	73	63	50	76	262
Total discharges	3368	3404	3503	3816	14091
Notifications per 1000 hospital discharges	21.7	18.5	14.3	19.9	18.6
Total days of hospitalization	16838	16508	15760	16610	65716
Notifications per 1000 days of hospitalization	4.3	3.8	3.2	4.6	4.0
Respiratory Diseases					
Number of notifications	30	65	51	26	172
Total discharges	1586	1533	1701	1766	6586
Notifications per 1000 hospital discharges	18.9	42.4	30.0	14.7	26.1
Total days of hospitalization	11928	11904	12472	12850	49154
Notifications per 1000 days of hospitalization	2.5	5.5	4.1	2.0	3.5

Variable	Categories
Severity	No patient harm 1 An error is possible No patient harm 2 An error occurred but it did not arrive to the patient Minimum The error did not produce any lesion Minor The error led to patient monitoring, but not to patient lesions Moderate 1 The error led to patient lesion and/or treatment Moderate 2 The error led to a patient's temporal lesion or a longer hospital stay Critic 1 The error has produced a permanent lesion Critic 2 The error has produced a life-threatening situation Catastrophic Lethal
Probability of occurrence	Very infrequent Exceptional (one time in more than 5 years) Not frequent Could happen once between 2 and 5 years Possible Could happen 1 or two times a year Probable Could happen a few times a year Frequent Could happen in the next weeks or months
Incident's type	Medication Falls Blood products Assistive devices Healthcare associated infection Nutrition Patient's behavior Oxygen and other medicinal gasses Documentation Clinic and procedures management Clinico-administrative management and laboratory Infrastructures

Figure 1 IRS Platform variables: severity, probability of occurrence and incident's type.

for activity during the study period (Gastroenterology & Metabolic Diseases) whereas others showed a decreasing trend (Cardiology & Cardiac surgery). The overall rates of notifications per 1000 hospital discharges and 1000 days of hospitalization increased from 2016 to 2018 and slightly decreased in 2019. Detailed rates are reported in Table 1.

Departments reporting the highest number of notifications were Emergency room, with 1212, Obstetrics & Gynaecology, with 1130 notifications. While Emergency departments are prone to notify more frequent incidents, the Obstetrics & Gynaecology department has a larger proportion of severe notifications when comparing to the distribution of severity in other departments. Regarding the type of incident, Falls were the most common; a total of 1352 Falls were reported during the study period, which represents a 21.19% of notifications. However, Falls were classified mostly as occasional or infrequent incidents by professionals (55.92 and 12.57%, respectively). Second most common type of incident was related to Medical and procedures management (18.91%). In third place were those related to Medication incidents (15.49%).

	Very infrequent	Not frequent	Possible	Probable	Frequent
No patient harm 1	Very low Risk	Very low Risk	Very low Risk	Low Risk	Low Risk
No patient harm 2	Very low Risk	Very low Risk	Very low Risk	Low Risk	Low Risk
Minimum	Low Risk	Low Risk	Low Risk	Low Risk	Moderate risk
Minor	Low Risk	Low Risk	Moderate risk	Moderate risk	Moderate risk
Moderate 1	Moderate risk	Moderate risk	High risk	High risk	High risk
Moderate 2	Moderate risk	Moderate risk	High risk	High risk	High risk
Critic 1	Moderate risk	High risk	High risk	Extreme risk	Extreme risk
Critic 2	Moderate risk	High risk	High risk	Extreme risk	Extreme risk
Catastrophic	Extreme risk	Extreme risk	Extreme risk	Extreme risk	Extreme risk

Figure 2 Calculation of incident's risk through the variables ''severity'' (transversal axis) and ''probability of occurrence'' (longitudinal axis).

Most frequent incidents are classified with low or moderate severity whereas less frequent notifications such as those related to blood products and oxygen are classified as high severity incidents. Nurses were the professionals who reported the highest number of notifications, in absolute value, reporting 60.44% of all notifications. Physicians were in second place, reporting 17.00% of incidents. However, considering the number of workers in each professional category, pharmacists were the professionals who notified more frequently, with 182.76 notifications per 100 workers in 2019, followed by nurses, with 52.42 notifications per 100 workers, assistant nurses with a rate of 51.63 and physicians, who reported 21.84 notifications per 100 workers in 2019. Administrative staff and other professionals had the lowest notification rates, with 3.08 and 2.78 notifications per 100 workers respectively. Administrative staff, doctors and medical residents notify a greater proportion of high severity incidents in comparison to other professionals. Pharmacists classified most of the reported incidents as frequent and minor severity. More than 75% of notifications referred to incidents occurred during the day shift. Notifications of night incidents were less frequent but more related to moderate and severe incidents. The most frequent way of knowing was the person's own experience (72.76%), followed by hearing from others (15.42%) and observed (11.82%). First-hand experienced incidents were more often classified as less severe and more frequent. Additionally, altogether, 28 sentinel events were notified (eight in 2016, five in 2017, twelve in 2018 and three in 2019).

Overall, contributor factors and people involved in the incident were more reported in those incidents classified as moderate or severe. The most frequent enabler factors reported as contributors to the incident were patients' (36.65%) and professionals' (35.49%). Incidents with a patient contributor were more often classified as moderate or severe in comparison to incidents with a professional enabler factor, classified mostly as no harm/minor harm. Patients were the most frequently involved in the incidents (69.69%) when the person involved was reported, further information in notification characteristics is shown in Tables 2 and 3.

In the models' construction, the inclusion of the moment of incident varied depending on the dependent variable assessed. On the one hand, none of the models included the holiday period as a significant variable through the Akaike Information Criterion. However, model B included the variable shift. Conversely, incident type and notifier characteristics (department and professional category) were consistently included in the three models.

In model A, Medical and procedures management incidents were consistently and significantly categorized as frequent (OR 2.21 [95% IC 1.30–3.76]) as well as Infrastructure incidents (OR 2.14 [95% IC 1.23–3.73]). In model B, where Analogic and digital documentation incidents was the reference category, all other incident types were significantly associated with higher reported severity notifications, However, Falls (OR 25.28 [95% IC 15.93–40.11]) and Oxygen & other gasses incidents (OR 12.19 [95% IC 3.62–41.07]) were the type of incidents more strongly associated with higher reported severity. Overall, in the adjusted model C, Falls (OR 13.79 [95% IC 7.47–25.46]), Patient Behaviour (OR 3.08 [95% IC 1.72–5.53]), Healthcare Associated Infection (OR 3.94 [95% IC 1.66–9.38]) and Medical and procedures management (OR 2.88 [95% IC 1.65–5.04]) were the incident types with more Risk OR.

Regarding notifiers characteristics, pharmacists and medical residents were the professional categories significantly associated with notifications categorized as frequent (OR 4.99 [95% IC 2.24–11.12] and 5.66 [95% IC 1.53–20.93] respectively). Whereas this tendency was maintained for severity in medical residents, pharmacists were the professionals that reported the mildest incidents (taken as a reference category in Model B). On the other hand, being a doctor or a nurse was significantly associated with the reporting of more severe incidents (OR 4.16 [95% IC 2.44–7.09] and 2.00 [95% 1.19–3.35]), respectively. When studying the association of areas of specialization, our data showed that medical and medical-surgical departments tend to report incidents that are considered more frequent in comparison to Surgery departments (non-statistically significant), whereas medical and surgical departments tend to report more severe notifications in comparison to

Table 2 Incident characteristics by probability. IRS, Hospital Clínic 2016–2019.

Variables	Total	Probability			Missing values	*p*-Value[a]
	N	Infrequent	Occasional/Probable	Frequent		
			N (% of total)			
Incident type						<0.000
Falls	1352	425 (31.46)	756 (55.92)	170 (12.57)	1 (0.07)	
Medical & Procedures Management	1205	214 (17.76)	468 (38.84)	523 (43.40)		
Medication	987	238 (24.11)	480 (48.63)	269 (27.25)		
Medical Devices	741	202 (27.26)	258 (34.82)	279 (37.65)	2 (0.27)	
Patient's Behaviour	574	135 (23.52)	210 (36.59)	226 (39.37)	3 (0.52)	
Infrastructures	525	112 (21.33)	135 (25.71)	277 (52.76)	1 (0.19)	
Analogic & Digital Documentation	413	104 (25.18)	190 (46)	119 (28.81)		
Clinical & Lab Management	243	53 (21.81)	115 (47.33)	75 (30.86)		
Nutrition	138	38 (27.54)	53 (38.41)	47 (34.06)		
Health-Care Associated Infection	106	20 (18.87)	43 (40.57)	43 (40.57)		
Blood Products	72	24 (33.33)	39 (54.17)	9 (12.5)		
Oxygen & Other gasses	15	8 (53.33)	3 (20)	4 (26.67)		
Non classified	8	2 (25.00)	1 (12.50)	5 (62.50)		
Department						<0.000
Cardiology & Cardiac Surgery	267	102 (38.20)	109 (40.82)	52 (19.48)	4 (1.50)	
Obstetrics & Gynaecology	1130	237 (20.97)	464 (41.06)	429 (37.96)		
Oncology & Haematology	439	116 (26.42)	206 (46.92)	117 (26.65)		
Gastroenterology & Metabolic Diseases	695	213 (30.65)	306 (44.03)	174 (25.04)	2 (0.29)	
Neurosciences	498	105 (21.08)	241 (48.39)	152 (30.52)		
Nephrology & Urology	268	61 (22.85)	128 (47.94)	78 (29.21)	1 (0.56)	
Internal Medicine & Infectious Diseases	458	146 (31.88)	234 (51.09)	78 (17.03)		
General Surgery & Anaesthesiology	495	140 (28.28)	190 (38.38)	165 (33.33)		
Orthopaedic Surgery & Rheumatology	247	64 (25.91)	108 (43.72)	75 (30.36)		
Respiratory Diseases	178	65 (36.52)	63 (35.39)	49 (27.53)	1 (0.56)	
Emergency department	1212	224 (18.48)	447 (36.88)	541 (44.64)		
Professional Category						<0.000
Doctor	993	168 (16.92)	401 (40.38)	424 (42.7)		
Nurse	3856	1029 (26.69)	1713 (44.42)	1109 (28.76)	5 (0.13)	
Assistant Nurse	454	130 (28.63)	167 (36.78)	157 (34.58)		
Medical Resident	52	3 (5.77)	15 (28.85)	34 (65.38)		
Pharmacist	175	15 (8.57)	118 (67.43)	42 (24.00)		
Administrative Staff	64	17 (26.56)	33 (51.56)	14 (21.88)		
Other	246	71 (28.86)	112 (45.53)	63 (25.61)		
Non-registered	539	142 (26.35)	192 (35.62)	203 (37.66)	2 (0.37)	
Shift						0.008
Night	1486	377 (25.37)	680 (45.76)	429 (28.87)		
Day	4893	1198 (24.48)	2071 (42.33)	1617 (33.05)	7 (0.14)	
Contributing Factor Reported						0.029
Yes	4579	1104 (24.11)	2028 (44.29)	1442 (31.49)	5 (0.11)	
No	1800	471 (26.17)	723 (40.17)	604 (33.56)	2 (0.11)	
Patient Was a Contributing Factor						<0.000
Yes	1678	442 (26.34)	829 (49.4)	404 (24.08)	3 (0.18)	
No	4701	1133 (24.10)	1922 (40.88)	1642 (34.93)	4 (0.09)	
Professionals Was a Contributing Factor						0.294
Yes	1625	380 (23.38)	723 (44.49)	522 (32.12)		
No	4754	1195 (25.17)	2028 (42.72)	1524 (32.1)	7 (0.15)	
Patient Involved						<0.000
Yes	4445	1125 (25.31)	1971 (44.34)	1345 (30.26)	4 (0.09)	
No	1934	452 (23.27)	780 (40.33)	701 (36. 25)	1 (0.16)	
Professional Involved						<0.000

Table 2 (*Continued*)

Variables	Total	Probability			Missing values	*p*-Value[a]
	N	Infrequent	Occasional/Probable	Frequent		
			N (% of total)			
Yes	1521	357 (23.47)	623 (40.96)	540 (35.50)	1 (0.07)	
No	4858	1218 (25.07)	2128 (43.80)	1506 (31.00)	6 (0.12)	
Way of Knowing						<0.000
Experienced	4186	956 (22.84)	1680 (40.13)	1545 (36.91)	5 (0.12)	
Observed	680	197 (28.97)	357 (52.5)	126 (18.53)		
Heard from Other	887	249 (28.07)	483 (54.45)	155 (17.47)		
Not informed	626	173 (27.64)	231 (36.90)	220 (35.14)	2 (0.32)	

[a]Statistical differences were calculated through the chi square test.

Table 3 Incident characteristics by severity. IRS, Hospital Clínic 2016–2019.

Variables	Total	Severity			Missing values	*p*-Value[a]
	N	No harm/Minor harm	Moderate	Severe		
			N (% of total)			
Incident type						<0.000
Falls	1352	607 (44.90)	738 (54.59)	7 (0.52)		
Medical & Procedures Management	1205	892 (74.02)	287 (23.82)	26 (2.16)		
Medication	987	783 (79.33)	196 (19.86)	8 (0.81)		
Medical Devices	741	523 (70.68)	205 (27.67)	12 (1.62)	1 (0.13)	
Patient's Behaviour	574	386 (67.25)	177 (30.84)	8 (1.39)	3 (0.52)	
Infrastructures	525	409 (77.90)	98 (18.67)	17 (3.24)	1 (0.19)	
Analogic & Digital Documentation	413	385 (93.22)	26 (6.30)	2 (0.48)		
Clinical & Lab Management	243	210 (86.42)	30 (12.35)	3 (1.23)		
Nutrition	138	123 (89.13)	15 (10.87)	0 (0.00)		
Health-Care Associated Infection	106	73 (68.87)	30 (2.83)	3 (2.38)		
Blood Products	72	49 (68.06)	19 (26.39)	4 (5.56)		
Oxygen & Other gasses	15	10 (66.67)	4 (26.67)	1 (6.67)		
Non classified	8	7 (87.5)	1 (12.5)	0 (0.00)		
Department						<0.000
Cardiology & Cardiac Surgery	267	181 (67.79)	78 (29.21)	4 (1.50)	4 (1.50)	
Obstetrics & Gynaecology	1130	825 (73.01)	267 (23.63)	38 (3.36)		
Oncology & Haematology	439	305 (69.48)	129 (29.38)	5 (1.14)		
Gastroenterology & Metabolic Diseases	695	471 (67.77)	217 (31.22)	7 (1.01)		
Neurosciences	498	330 (66.27)	166 (33.33)	2 (0.40)		
Nephrology & Urology	267	190 (71.16)	76 (28.46)	1 (0.37)	1 (0.56)	
Internal Medicine & Infectious Diseases	458	297 (64.85)	160 (34.93)	1 (0.22)		
General Surgery & Anaesthesiology	495	365 (73.74)	122 (24.65)	1 (1.62)		
Orthopaedic Surgery & Rheumatology	247	148 (59.92)	95 (38.46)	4 (1.62)		
Respiratory Diseases	178	128 (71.91)	44 (24.72)	5 (2.81)	1 (0.56)	
Emergency department	1212	848 (69.97)	353 (29.13)	11 (0.91)		
Professional Category						<0.001
Doctor	993	653 (65.76)	307 (30.92)	33 (3.32)		
Nurse	3856	2622 (68.07)	1196 (31.05)	34 (0.88)	4 (0.10)	4 (0.10)
Assistant Nurse	454	361 (79.52)	91 (2.04)	2 (0.44)		
Medical Resident	52	27 (51.92)	23 (44.23)	2 (3.85)		
Pharmacists	175	157 (89.71)	17 (9.71)	1 (0.57)		
Administrative Staff	64	54 (84.38)	7 (10.94)	3 (4.69)		
Other	246	180 (73.17)	65 (26.42)	1 (0.41)		
Non-registered	539	403 (74.77)	120 (22.26)	15 (2.78)	1 (0.79)	

Table 3 (*Continued*)

Variables	Total	Severity			Missing values	*p*-Value[a]
	N	No harm/Minor harm	Moderate	Severe		
			N (% of total)			
Shift						<0.000
Night	1486	913 (61.44)	544 (36.61)	29 (1.95)		
Day	4893	3544 (72.43)	1282 (26.20)	62 (1.27)	5 (0.10)	
Contributing Factor Reported						<0.000
Yes	4579	3019 (65.93)	1490 (32.54)	67 (1.46)	3 (0.07)	
No	1800	1438 (79.89)	336 (18.67)	24 (1.33)	2 (0.11)	
Patient Was a Contributing Factor						<0.000
Yes	1678	868 (51.73)	786 (46.84)	22 (1.31)	2 (0.12)	
No	4701	3589 (76.35)	1040 (22.12)	69 (1.47)	3 (0.06)	
Professionals Was a Contributing Factor						0.029
Yes	1625	1160 (71.38)	434 (26.71)	31 (1.91)		
No	4754	3297 (69.35)	1392 (29.28)	60 (1.26)	5 (0.10)	
Patient Involved						<0.000
Yes	4445	2870 (64.57)	1516 (34.11)	57 (1.28)	2 (0.04)	
No	1934	1587 (82.06)	310 (16.03)	34 (1.76)	3 (0.16)	
Professional Involved						<0.000
Yes	1521	1249 (82.12)	242 (15.91)	29 (1.91)	1 (0.07)	
No	4858	3208 (66.04)	1584 (32.61)	62 (1.28)	4 (0.08)	
Way of Knowing						<0.000
Experienced	4186	3040 (72.62)	1093 (26.11)	49 (1.17)	4 (0.10)	
Observed	680	387 (56.91)	283 (41.62)	10 (1.47)		
Heard from Other	887	561 (63.25)	309 (34.84)	17 (1.92)		
Not informed	626	469 (74.92)	141 (22.52)	15 (2.40)	1 (0.16)	

[a]Statistical differences were calculated through chi square test.

medical-surgical departments. Further OR and 95% CI of the three models can be observed in Table 4

Discussion

Since the implementation of the IRS system in the Hospital Clinic de Barcelona, the overall notification rate increased during the first years of implementation, stabilizing during the last year analyzed. Nurses were the professional category that notified the most, followed by doctors. Falls were the most frequent incident notified, followed by Medical and procedures management and Medication notifications. While the decrease in the number of notifications in 2019 can be interpreted as a regression towards the mean (or stabilization of the tendency), the great number of Falls notifications may be related to the previous existence of a Falls notification system in our hospital. Moreover, it might be associated with how easier it could be for professionals to notify incidents they attribute to be related to a patient's action or environmental conditions. This system was led by nurses and implemented before the IRS and might have contributed to the hospital's safety culture. The same reasoning applies to the great number of notifications in the Obstetrics & Gynaecology department and the Emergency room, two departments that were pioneers in safety culture in the Hospital Clinic of Barcelona.

As in previous evidence,[12] Falls were the incident most frequently reported, it was one of the incidents perceived as less frequent. The opposite notification pattern can be observed in Health-care Associated Infections. These are perceived as being frequent and minor, however, they were the third least frequently notified and a recognized cause of healthcare associated deaths.[22] As such, the notifier's perception did not reflect neither the healthcare professionals' notification behaviour nor patient safety risks. Nevertheless, this provides us an overview of what the professional perception about patient risk is and this could be used as a tool to improve notification behaviours and safety culture.

Globally, incidents perceived as less severe (no harm or minor harm) were more notified, and in line with previous research, incidents were more frequently reported when they rely on the professional's direct experience.[14] Over the four years of the period study, most notifications of incidents considered as mild are notified by nurses, whereas notifications of the severe ones are done both by nurses and doctors. This is consistent with previous literature.[12,14–16] However, physicians have been identified as the most notifying professionals in some specific IRS[7] and when adjusting by the total number of hours worked.[3]

Conversely, pharmacists consistently tend to notify incidents perceived as minor and more frequent. These differences in notification patterns could depend on context,

Table 4 Probability, severity and risk by reported incident characteristics.

	Model A: Reported Probability			Model B: Reported Severity			Model C: Calculated Risk		
	Odds Ratio	[OR 95% Conf. Interval]		Odds Ratio	[OR 95% Conf. Interval]		Odds Ratio	[OR 95% Conf. Interval]	
Shift									
Night				1.00					
Day				0.76	0.66	0.87			
Type of Incident									
Blood products	1			7.81	3.93	15.50	1.00		
Falls	1.189	0.707	1.999	25.28	15.93	40.11	13.79	7.47	25.46
Patient behaviour	1.668	0.968	2.872	9.63	5.95	15.60	3.08	1.72	5.53
Medical devices	1.340	0.786	2.284	7.72	4.80	12.43	2.23	1.27	3.93
Analogic & digital documentation	1.375	0.788	2.399	1.00			1.03	0.58	1.82
Clinical & Lab Management	1.628	0.896	2.959	2.49	1.39	4.44	1.95	1.03	3.68
Medical & procedures management	2.211	1.301	3.757	5.14	3.23	8.17	2.88	1.65	5.04
Health-care associated infection	1.913	0.943	3.881	9.06	4.87	16.88	3.94	1.66	9.38
Infrastructures	2.138	1.226	3.730	4.66	2.83	7.66	2.42	1.35	4.34
Medication	1.352	0.796	2.296	5.28	3.28	8.50	1.48	0.85	2.57
Nutrition	1.292	0.674	2.475	2.69	1.29	5.62	2.30	1.12	4.70
Oxygen & other gasses	0.454	0.136	1.513	12.19	3.62	41.07	2.43	0.49	12.03
Medical or Surgical Departments									
Surgery	1.00			1.99	1.26	3.14	1.91	1.13	3.24
Medical	1.171	1.000	1.372	1.71	1.11	2.66	1.59	0.97	2.61
Medical-Surgical Departments	0.778	0.520	1.166	1.00			1.00		
Others	1.247	0.984	1.580	2.07	1.29	3.31	1.97	1.14	3.40
Professional category									
Administrative stuff	1			1.78	0.73	4.32	1.00		
Doctors	1.827	0.996	3.353	4.16	2.44	7.09	3.09	1.65	5.79
Nurses	1.219	0.676	2.198	2.00	1.19	3.35	2.03	1.11	3.70
Pharmacists	4.991	2.240	11.120	1.00			1.51	0.75	3.03
Assistant Nurse	1.129	0.602	2.119	1.24	0.69	2.22	1.42	0.74	2.74
Medical Residents	5.659	1.530	20.931	6.82	3.19	14.57	9.65	2.07	45.05
Others	0.981	0.521	1.843	1.76	0.99	3.13	2.16	1.10	4.25

time spent with the patient,[23] patient safety awareness, safety cultural background and type of healthcare activity. Although different patterns between pharmacists, doctors and nurses are probably related to job characteristics (relationship with the patient, level of responsibility), it has been shown that professionals tend to notify incidents that potentially have more direct and quick solutions, such as Falls or Medication.[14] Considering these dimensions in further analysis could help characterize patient risk misconceptions among different professional groups and design interventions that could be adapted to the group safety culture.

IRSs have been recently overlooked as a surveillance tool and as a proxy of patient safety due to the dependence on notifiers' perspective. Nevertheless, recognizing the different notification patterns and professional risk perceptions, IRS information can be analyzed in conjunction with mortality, morbidity and work-related data to build interventions in order to improve safety culture.[24] Moreover, personalized feedback on IRS information reporting, could be used as a patient safety learning platform.[25] The identification of notification gaps (such as the lack of notifications of severe healthcare related infections) and notification reporting patterns (qualify Falls as not as frequent) in professional groups or departments can be used as a tool to work over patient risks, safety and developed safety culture in a more contextualized way.

This study shows notification department's activity and offers the possibility of analyzing departments and professional's notifying patterns, allowing contextualized comparison of safety culture. We also provide a more in-depth analysis about notifiers perception by using a calculated risk variable. Nevertheless, some departments, such as Surgery, notify by department-specific IRS which has led to an underrepresentation of this group of notifiers. As this study does not aim to analyze incidents, but notifications, no proxy patient safety indicator was calculated, and no direct measure of patient safety can be obtained through this study, however, this data provides a framework for future analysis and provides indirect quantitative data on notifiers risk perception. Even though we considered the potential relevance of shifts or holidays in our models, more detailed analysis considering professional hours worked or time should be performed in order to evaluate how this can evaluate the notification rate. As Tricarico et al. referred, changes in the notification rate overtime or per working hour could help contextualize safety risk perceptions or notification patterns[3] which might imply continuous improvement of IRS reporting.[26]

In conclusion, IRS data analysis can provide sectorize information about notification patterns that show notifiers' patient risk perception. Our results show how incidents perceived as minor and frequent are less frequently notified while incidents perceived as less frequent are the most frequently notified. Moreover, the professional category and department play a role in notification culture.

Conflicts of interests

The authors declare no conflict of interest in this article.

References

1. Pham JC, Girard T, Pronovost PJ. What to do with healthcare incident reporting systems. J Public Health Res. 2013;2:27, http://dx.doi.org/10.4081/jphr.2013.e27.
2. Ocak S, Köseoglu MA, Bertsch A. Linkages among organisational culture, knowledge management, and patient safety performance: evidence from a state hospital in a developing country. Int J Manag Enterp Dev. 2015;14:11–35, http://dx.doi.org/10.1504/IJMED.2015.069307.
3. Tricarico P, Castriotta L, Battistella C, Bellomo F, Cattani G, Grillone L, et al. Professional attitudes toward incident reporting: can we measure and compare improvements in patient safety culture? Int J Qual Heal Care. 2017;29:243–9, http://dx.doi.org/10.1093/intqhc/mzx004.
4. Nakajima K, Kurata Y, Takeda H. A web-based incident reporting system and multidisciplinary collaborative projects for patient safety in a Japanese hospital. Qual Saf Heal Care. 2005;14:123–9, http://dx.doi.org/10.1136/qshc.2003.008607.
5. Howell AM, Burns EM, Bouras G, Donaldson LJ, Athanasiou T, Darzi A. Can patient safety incident reports be used to compare hospital safety? Results from a quantitative analysis of the English national reporting and learning system data. PLOS One. 2015;10, http://dx.doi.org/10.1371/journal.pone.0144107.
6. Gibbs NM, Culwick M, Merry AF. A cross-sectional overview of the first 4,000 incidents reported to webAIRS, a de-identified web-based anaesthesia incident reporting system in Australia and New Zealand. Anaesth Intensive Care. 2017;45:28–35, http://dx.doi.org/10.1177/0310057X1704500105.
7. Welker AS, Pierre MS, Heinrichs W, Ghezel-Ahmadi V, Schleppers A. The German critical incident reporting system for anesthesiology: CIRSains. J Patient Saf. 2015;11:204–9, http://dx.doi.org/10.1097/PTS.0000000000000069.
8. Mansouri M, Shaqdan KW, Aran S, Raja AS, Lev MH, Abujudeh HH. Safety incident reporting in emergency radiology: analysis of 1717 safety incident reports. Emerg Radiol. 2015;22:623–30, http://dx.doi.org/10.1007/s10140-015-1336-3.
9. Milosevic M, Angers C, Liszewski B, Drodge CS, Marchand EL, Bissonnette JP, et al. The Canadian National System for Incident Reporting in Radiation Treatment (NSIR-RT) Taxonomy. Pract Radiat Oncol. 2016;6:334–41, http://dx.doi.org/10.1016/j.prro.2016.01.013.
10. Galván Núñez P, Santander Barrios MD, Villa Álvarez MC, Castro Delgado R, Alonso Lorenzo JC, Arcos González P. Results of provisional use of a system for voluntary anonymous reporting of incidents that threaten patient safety in the emergency medical services of Asturias. Emergencias. 2016;28:146–52.
11. Agencia de Calidad del Sistema Nacional de Salud Ministerio de Sanidad y Política Social. El Establecimiento de Un Sistema Nacional de Notificación y Registro de Incidentes y Eventos Adversos En El Sector Sanitario: Aspectos Legales; 2009. https://www.sanidad.gob.es/ca/organizacion/sns/planCalidadSNS/docs/Establecimiento_Sistema_Nacional_Notificacion.pdf [accessed 15.01.21].
12. Oliva G, Álava F, Navarro L, Esquerra M, Lushchenkova O, Vallès JDYR. Notificación de incidentes relacionados con la seguridad del paciente en los hospitales de Cataluña durante el período 2010-2013. Med Clin (Barc). 2014;143 Suppl. 1:55–61, http://dx.doi.org/10.1016/j.medcli.2014.07.012.
13. Agencia de Calidad del Sistema Nacional de Salud Ministerio de Sanidad y Consumo. Sistemas de registro y notificación de incidentes y eventos adversos; 2005. https://www.sanidad.gob.es/organizacion/sns/planCalidadSNS/pdf/excelencia/opsc_sp3.pdf [accessed 15.01.21].
14. Evans SM, Berry JG, Smith BJ, Esterman A, Selim P, O'Shaughnessy J, et al. Attitudes and barriers to incident

reporting: a collaborative hospital study. Qual Saf Heal Care. 2006;15:39–43, http://dx.doi.org/10.1136/qshc.2004.012559.
15. Ramírez E, Martín A, Villán Y, Lorente M, Ojeda J, Moro M, et al. Effectiveness and limitations of an incident-reporting system analyzed by local clinical safety leaders in a tertiary hospital: prospective evaluation through real-time observations of patient safety incidents. Med (United States). 2018;97, http://dx.doi.org/10.1097/MD.0000000000012509.
16. Walsh K, Antony J, Burns C. Electronic adverse incident reporting in hospitals. Leadersh Heal Serv. 2010;23:292–303, http://dx.doi.org/10.1108/17511871011079047.
17. Font D, Escarrabill J, Gómez M, Ruiz R, Enfedaque B, Altimiras X. Integrated Health Care Barcelona Esquerra (Ais-Be): a global view of organisational development, re-engineering of processes and improvement of the information systems. The role of the Tertiary University Hospital in the transformation. Int J Integr Care. 2016;16:8, http://dx.doi.org/10.5334/ijic.2476.
18. Prat A, Bertrán MJ, Santiñà M, Vilella A, Asenjo MA, Trilla A. Organización en institutos de gestión clínica (centros orientados al paciente): descripción de la utilización hospitalaria. Rev Calid Asist. 2008;23:21–5, http://dx.doi.org/10.1016/S1134-282X(08)70463-9.
19. Flexible software to analyze incidents in healthcare.
20. WHO. Conceptual framework for the international classification for patient safety final technical report; 2009.
21. Bozdogan H. Model selection and Akaike's Information Criterion (AIC): the general theory and its analytical extensions. Psychometrika. 1987;52:345–70, http://dx.doi.org/10.1007/BF02294361.
22. Klevens RM, Edwards JR, Richards CL, Horan TC, Gaynes RP, Pollock DA, et al. Estimating health care-associated infections and deaths in U.S. Hospitals, 2002. Public Health Rep. 2007;122:160–6, http://dx.doi.org/10.1177/003335490712200205.
23. Urich B. Patient safety – what is your role? Nephrol Nurs J. 2015;42:107.
24. Flott K, Nelson D, Moorcroft T, Mayer EK, Gage W, Redhead J, et al. Enhancing safety culture through improved incident reporting: a case study in translational research. Health Aff. 2018;37:1797–804, http://dx.doi.org/10.1377/hlthaff.2018.0706.
25. Arnal-Velasco D, Barach P. Anaesthesia and perioperative incident reporting systems: opportunities and challenges. Best Pract Res Clin Anaesthesiol. 2021;35:93–103, http://dx.doi.org/10.1016/J.BPA.2020.04.013.
26. El-Sherbiny NA, Ibrahim EH, Abdel-Wahed WY. Assessment of patient safety culture among paramedical personnel at general and district hospitals, Fayoum Governorate, Egypt. J Egypt Public Health Assoc. 2020;95, http://dx.doi.org/10.1186/s42506-019-0031-8.