The immediate treatment outcomes and cost estimate for managing clinical measles in children admitted at Mulago Hospital: a retrospective cohort study

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Abstract

Background: Over the recent years, the Ministry of Health in Uganda has reported multiple measles outbreaks in various districts despite the availability of a safe cost effective vaccine. Measles, especially among the unvaccinated, can lead to serious complications including death, while its management heavily burdens the family and health care delivery system. Whereas the cost of measles vaccination is known, the cost of treating measles is unknown. Knowledge of this can inform policy and planning for healthcare services.

Method: A retrospective single cohort study using records review was conducted to determine the immediate treatment outcomes and estimate the health care delivery cost of managing measles among children 0-12 years admitted at Mulago hospital throughout 2018. Demographics, complications, vaccination status, discharge status, duration of hospital stay, type of treatment, supplies used and investigations done were abstracted from the patient charts. The costs of treatment were obtained from the hospital pharmacy price list while the unit cost of utilities, human resource, food and security were obtained from the hospital accounts department. Patients' characteristics were summarized descriptively. For all cost information, we reported the mean with standard deviation (SD) and range, and costs information was stratified and presented as direct health care (blood test, radiology and treatment) and direct non health care.

Results: Out of 536 patient charts, 267 were chosen, 51% were for females and the median age was 1.0 (IQR 0.75-2) years. Sixty-three patients (24%) were immunised, 79 (29%) were not immunized, 56 (21%) were not due for immunisation at the time of hospitalisation while the status of 69 (26%) was not recorded. Median length of hospital stay was 4.0 days (IQR 3.0-7.0) with majority (n=207, 77%) staying < 7 days. There were 30 deaths (11%) with mortality highest among the unimmunised (n= 13, 44%) and severe pneumonia (39.5%) was the commonest complication.

The average cost estimate to the health care delivery system to treat a child with measles was (114.5 USD). Human resource (79.33USD, SD 4.63) and treatment costs (21.98USD, SD 22.77) were the largest expenses.

Conclusions: Mortality among children with measles was high and occurrence of complications common. The estimated average direct health care cost of treating a measles case in the National Referral Hospital was considerably high. Further research is required to estimate the cost to the family and society in managing a child with measles.

Key words

Measles, Cost, direct health care cost, direct non health care cost

Introduction:

Measles is a highly contagious viral disease which is largely preventable through vaccination [1]. Globally, measles accounts for over 140,000 deaths annually, mostly among children under five [1] and is still common in many developing countries – particularly in parts of Africa and Asia. The overwhelming majority (more than 95%) of measles deaths occur in countries with low per capita income and weak health infrastructure [1-3].

In Uganda, the Ministry of Health continues to register measles outbreaks almost every year despite the availability of free effective vaccines in public health facilities, with Wakiso and Kampala districts amongst those most commonly affected [4]. Outbreaks have also been reported in several other districts, including a recent one in Nakaseke [5], and a more widely spread one in 2018 involving 26 districts [6]. As a result, measles is one of the leading causes of death among children under 5 years in the country, and contributes 4% to under 5 mortality [7].

To prevent measles outbreaks, WHO had set an ambitious but achievable target of vaccinating $\geq$ 95% of the susceptible children by 2020, which would help create hard immunity [8]. Findings from the Uganda Demographic and Health survey (2016) showed variation between districts in measles vaccine coverage, which was less than optimum. Coverage ranged between 60% in Wakiso and 82.8% in Kampala with a national average of 80% [9]. Low levels of immunization coverage translate to low immunity at community level, which ultimately may lead to an outbreak of measles if the virus is introduced.

Besides morbidity and mortality, costs related to treating a child with measles pose a big burden to the family and the already financially stretched health care delivery system, and are increased when the measles is complicated. While the cost of immunizing a child is estimated at only $ 0.86 [$0.42 being cost for vaccine and injection material and $0.44 for operational costs] [10], the cost incurred to the health care delivery system in managing measles in Uganda has not been well described. This study therefore sought to estimate the cost to the health care delivery system in

managing a child with measles. Knowledge of this would inform policy related to promotion of immunisation and planning for hospital services.

Methods

Study design and setting

A retrospective cohort study through records review was conducted at Mulago National Referral Hospital (MNRH), which is the teaching Hospital of Makerere University College of Health Sciences. This Public health facility is owned by the Uganda Ministry of Health and is located in the central division of Kampala district. MNRH serves about 115,000 in and out patients including 30,000 children per year with a bed capacity of 1790.

Study procedure

A list of the measles admissions from 1st January 2018 to 31st December 2018 with inpatient numbers was made from the Health Management Information System register to determine the total number of measles admissions at MNRH by the principal investigator with the help of the hospital records officer.

The available charts were retrieved by the records officer and reviewed for eligibility of data by the principal investigator. Those with incomplete data like undocumented inpatient number, age, and sex were excluded. In addition, charts where the child's clinical features did not meet criterion for clinical measles were excluded [11]. Charts that passed these criteria were arranged and grouped by date of admission starting with January 1st 2018. Using systematic sampling technique, the sampling frame was 536 charts and the sample size of 267 was calculated using the formula for fixed populations. We obtained a skip interval (k=2), and every second chart was chosen until the required sample size was achieved. The first chart was selected using simple random sampling. Information abstracted from the patient's charts included: Demographics (age, gender), complications, co-morbidities, vaccination status, vital status (alive or dead) at discharge and date of admission and discharge/death. The type of treatment, dosage and duration of use, supplies and investigations were also obtained from the patient charts and their unit costs were obtained from the hospital pharmacy price list.

Costs were classified as direct health care (drugs, supplies and investigations) and direct non health care /overhead costs (security, salaries, water, electricity, food). The direct non health care costs were obtained from the hospital accounts department.

Unit costs were obtained using the price list from the hospital. Market prices were used for those items that were not in the price list. Total costs per patient were calculated and average costs determined.

Data management and analysis.

Each data abstraction form (DAFs) was assigned a study number, which was used alongside the inpatient numbers to enter data. These were checked against the patient's record daily for completeness and accuracy. The abstracted data was stored in a safe place under lock and key. Data was entered into an electronic database using Epidata version 3.1 with in-built quality control checks. The final data was then backed up, stored on a password-protected computer, and exported to STATA version 13 for analysis.

Continuous variables were summarised using medians with interquartile ranges and means with standard deviations. The data was examined for the normality statistical assumption. Analysis of variance (ANOVA) were used to compare the average direct costs across patient demographic and clinical characteristics, and a P-value of < 0.05 was considered statistically significant.

Ethics approval and consent

Ethical approval was sought and obtained from School of Medicine Research and Ethics Committee (SOMREC) and The Mulago Hospital Institution Review Board. A waiver of consent was sought and obtained from SOMREC to use the patient charts. All the information was kept confidential.

Results

A total of 570 patients were admitted between 1st January and 31st December 2018 with a clinical diagnosis of Measles and we managed to retrieve 553 (97%) charts. We excluded 16 charts: Six of them had missing documentation of sex and age and 10 had no clear definition of clinical measles.

Demographic and clinical characteristics

After sampling, 267 patients' charts were chosen, 135 (51%) for females and 132 (49%) for males. The median age was 1.0 year (IQR 0.75-2.0) with majority aged < 1 year (n=169, 63%). The median length of hospital stay was 4.0 days (IQR 3.0-7.0). Thirty (11%) died during admission whereas 237 (89%) were discharged alive as described in Table 1.

Table 1: The demographic and clinical characteristics of 267 patients with clinical measles admitted to Mulago Hospital from 1st January 2018 to 31st December 2018

Variable	Category	n (%)
Gender	Male	132 (49.4%)
	Female	135 (50.6%)
Age	Age in years, Median (IQR)	1.0 (0.75-2.0)
Immunization status	Yes	63 (23.6%)
	No	79 (29.6%)
	Unknown	69 (25.8%)
	Not due	56 (21.0%)
Co-morbidities at admission	Yes	23 (8.6%)
	No	244 (91.4%)

Immediate treatment outcomes.

Complications developed during hospital stay.

During the period of admission, 185 (69.3%) patients had multiple complications and these included severe pneumonia (39.5%), gastroenteritis (24.0%), conjunctivitis (18.0%), malnutrition (6.4%), encephalitis (2.2%), among others as illustrated in the Figure 1 below.

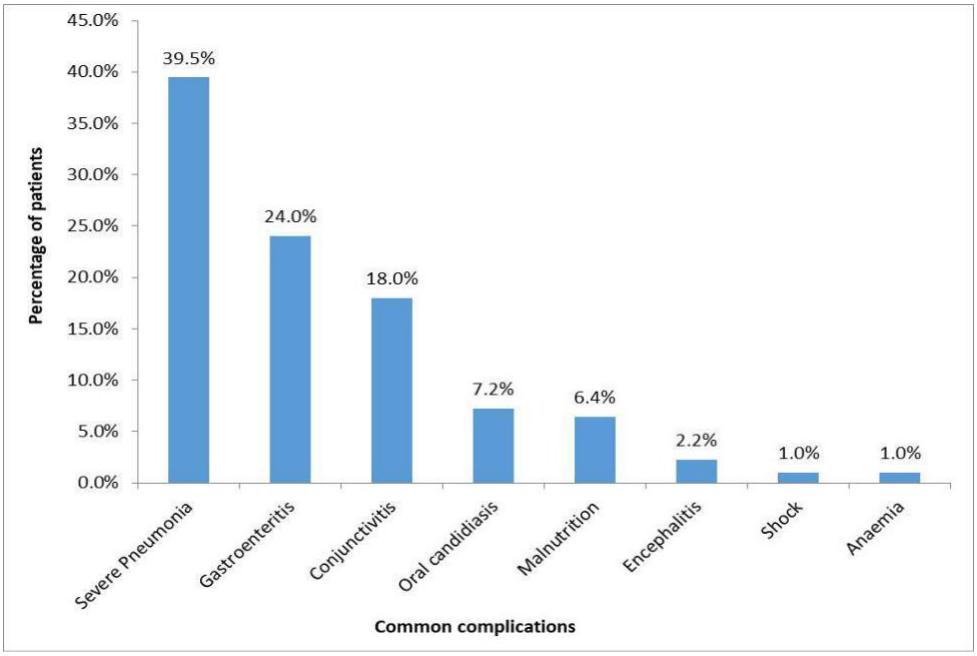

Figure 1: Diagnoses/common complications of 185 patients during hospital stay.

Mortality of patients with measles and their characteristics

A total of 30 (11.3%) patients died during hospital stay. Out of these, 17 (57%) were male. 21 (70%) of these were aged between 0-1 years and 13 (44%) were not immunized. Majority 26 (86%) had spent < 7 days in the hospital as summarised in supplementary table **S1.**

Figure 2 below summarises complications found among the 30 patients who died during admission

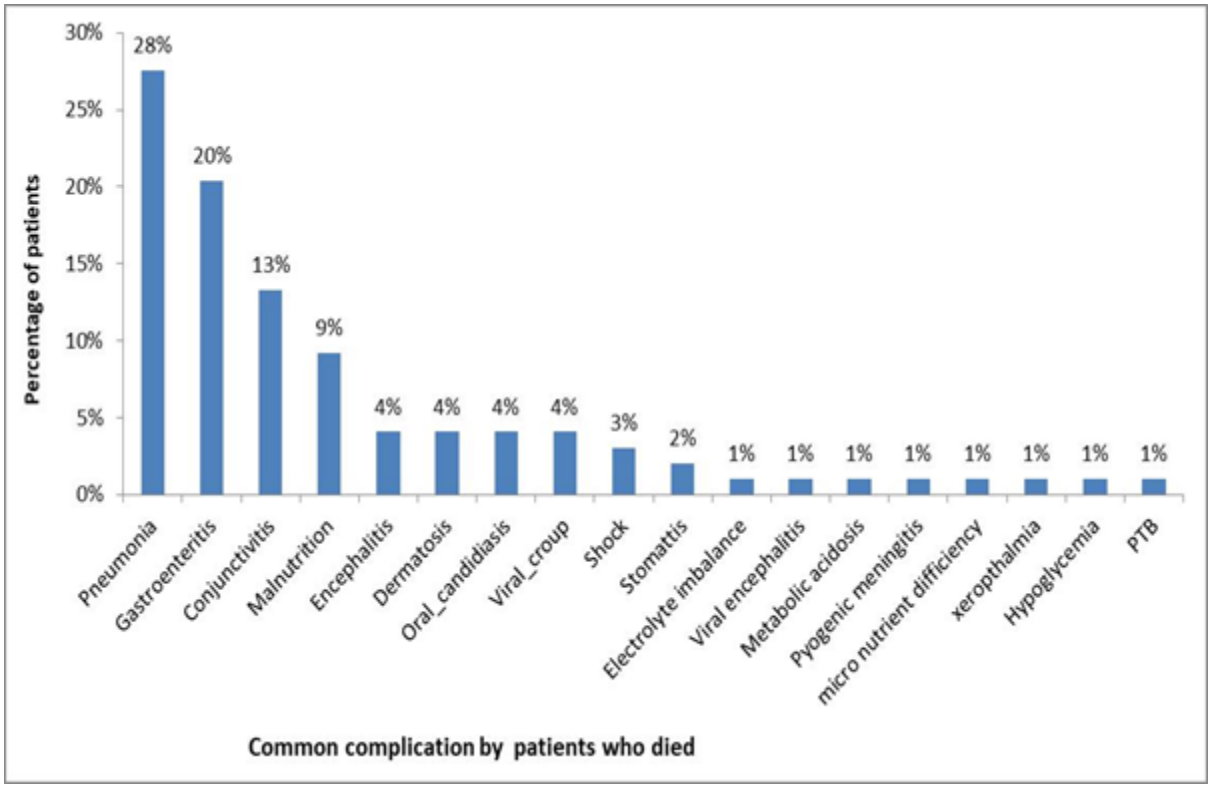

Figure 2: Complications among 30 patients who died during admission

Duration of hospital stay and characteristics among the 60 patients who stayed longer than 7 days.

The median length of hospital stay among children admitted with measles was 4.0 (IQR 3.0-7.0) days. 207 (77%) stayed less than 7 days while 60 (13%) stayed longer than 7 days. Of these, 46 (77 %), were less than one year and 36 (60 %) were male as shown in supplemental table **S2**.

Costs of Managing a child with Measles

Direct health care costs (USD): Direct health care costs were divided into 3 categories i.e. blood tests, radiology and treatment costs. The average cost of blood test per patient was 11.73USD (SD=12.10); for radiology, the average cost per patient was 3.48USD (SD=4.83); and 21.98USD (SD=22.77) for treatment. The overall average cost per patient was 33.13 USD (SD=30.45).

Direct non health care cost / Overhead costs (USD): The overhead costs that were shared by the patients included human resource costs (79.33USD), SD=4.63) and maintenance and utilities (2.04USD), SD=0.27) giving rise to a total of 81.37USD.

These costs are summarised in **Table 2** below.

Table 2: The average direct health care and non-health care (overhead) costs for managing measles per patient.

Health care costs	Item	Average cost (USD)	Standard deviation	Range (USD)
	Blood test	11.73	12.10	1.35-59.49
	Radiology	3.48	4.83	1.35-43.27
	Treatment	21.98	22.77	2.57-211.22
	Total cost	**33.13**	**30.45**	4.80-216.64
Non-health care costs	Human resource	79.33	4.63	1.35 – 17.56
	Maintenance, utilities,	2.04	0.27	0.02 – 8.18
	Total cost	**81.37**	**14.09**	

Comparison of direct costs incurred by patient characteristics

Male patients incurred higher average costs (36.08USD, SD=35.09) than their female counterparts (30.24USD, SD=24.89), (F=6.126, P=0.011). Patients that had comorbidities/long standing illness recorded during admission period incurred higher average costs (45.00USD, SD=36.49) than those who had no comorbidities (32.02USD, SD=29.67), (F=2.163, P=0.04).

Patients who stayed for over 15 days in the hospital incurred higher average costs (127.08, SD=56.36) than those who stayed between 8-15 days (57.07, SD=25.68), and those who stayed for less than 8 days (22.81, SD=15.08), (F=170.262, P=0.0001).

At the time of discharge, the patients who died had incurred higher average cost (47.13, SD=44.89) than those discharged alive (31.36, SD=27.74), (F=4.49, P=0.03). These findings are summarized in the **Table 3** below.

Table 3: Comparison of direct costs (USD) incurred by patient characteristics

Variable	Category	Average cost (SD)	F-Statistic	P-Value
Gender	Male	36.08(35.09)	6.126	0.011
	Female	30.24(24.89)		
Age (Years)	<1	34.76 (29.29)	2.206	0.112
	2-5	28.04 (28.14)		
	Over 5	42.98 (48.96)		
Immunization status	Yes	36.49(37.36)	0.738	0.530
	No	35.40 (33.91)		
	Unknown	30.39 (24.71)		
	Not due	30.04 (22.10)		
Comorbidities	Yes	45.00(36.49)	2.163	0.04
	No	36.02 (29.67)		
Hospital days	< 8	22.81 (15.08)	170.262	0.0001
	8-15	57.07 (25.68)		
	>15	127.08 (56.36)		
Status at discharge	Dead	47.13 (44.89)	4.49	0.03
	Alive	31.36 (27.74)		

Discussion

We carried out a retrospective cohort study to describe the immediate outcomes of children admitted with clinical measles and to estimate the direct cost of managing a severe measles case in MNRH, Uganda.

Immediate treatment outcomes

Complicated measles runs a severe course and can lead to death. In this study, mortality was higher than that found in two studies done in hospitals in Pakistan (5.4% and 3.4%) [12, 13]. Mortality was found highest among the children who were not immunised, possibly because they developed severe complications. Measles related mortality is primarily due to an increased susceptibility to secondary bacterial and viral infections, resulting from direct mucosal damage by measles infection and measles induced immune suppression [14]. While pneumonia was the most prevalent complication among the participants, acute watery diarrhoea (gastroenteritis) was also common. These complications were similarly found to be the most prevalent in a study done in Pakistan with pneumonia and diarrhoea reported in 39.7% and 38.2% of children respectively [15].

Pneumonia like measles in children is largely preventable through vaccination. In children who are not immunised it can lead to severe disease which may result in death. This study showed that pneumonia was the commonest complication among children who died, having been diagnosed in more than a quarter of these; and since majority (44.0%) were not immunised, it is possible that they had also missed the rest of the vaccinations including those for pneumococcal pneumonia and influenza. This was similarly demonstrated in a study done in Queen Elizabeth Central Hospital in Malawi where pneumonia was the greatest contributor to mortality [16]. However it is in contrast to findings from a study done in Ayub teaching hospital where encephalitis was the leading cause of death [15].

The median length of hospital stay was 4.0 days with about three quarters of babies staying less than seven days. This was similarly found in a study done in Pakistan about the clinical outcome of hospitalised measles patients where the mean hospital stay was 3.8 days [15].

Estimated cost of managing a child with measles.

In management of children hospitalised due to measles, both healthcare costs and non-health care costs are incurred. However, this study looked at only the costs borne to the health care delivery system. The study found that the estimated direct cost borne by the health care system (laboratory test, radiology and treatment plus supplies cost) was on average 122,500 Ugandan shillings which is approximately 33.13 US dollars (1 US Dollar=3697.92 UGX) [17] , much of which goes to treatment and supplies.

The average overhead cost was 81.37 US dollars most of which goes to human resource (salaries) to care for these patients. Thus, the total estimated direct cost of treating a measles case was substantially high (114.50 USD). This is higher than the cost determined by Gatien De Broucker and colleagues in another study conducted in Uganda [18]. Our costs were higher possibly because the study was conducted in a National Referral Hospital where severe cases of measles are referred.

Such costs are far beyond the cost required to immunise a child against measles which the World Health Organisation estimates to be less than a dollar [9, 19]. This is strong ground to base on to promote vaccination, which should eventually reduce health expenditure here incurred by government, but possibly by individuals as well.

In this study, higher costs of treating a measles case were found among the male gender, those with co-morbidities, those that were admitted longest (> 15 days), and those that died during admission. Not surprisingly, patients that had co-morbidities during admission incurred higher average costs (44.99 USD) than those who had no co-morbidities. The possible explanation for

this is that those with co-morbidities had to be managed for both measles in addition to other co-morbidities. It is also possible that those with co-morbidities had severe measles infection due to severe immune suppression, both by the measles and the co-morbidity. Management of such patients requires more investigations and perhaps more expensive treatment, which in turn increases the cost of health care delivery.

Patients who also stayed longer in hospital (> 15 days) incurred higher average costs than those who stayed for less days. These children were possibly too sick and required more aggressive and/or prolonged treatment and investigations which increased the direct cost of health care delivery. At the time of discharge, those who died incurred more average direct costs (47.13 USD) than those who were alive despite the fact that they spent less days. This is possibly because those who died were severely sick and required more expensive treatment and more investigations to be done than those who were discharged alive. Managing a male patient was found to be costlier than a female one, possibly because as demonstrated, males were admitted longer and were more likely to die than females.

To our knowledge, this is the first study that has estimated the direct cost of managing a child with clinical measles in a National Referral Hospital in Uganda.

This study had limitations. It was done in a public hospital and findings may not be similar in private facilities. It is more likely that costs in private facilities are even higher since these are established to make profit as was found by Gatien De Broucker et al [18].

Since this study was retrospective, it was only possible to enumerate costs to the health care delivery system but not costs to the family or society as these would require real time interaction with the family. It would have been useful to document costs incurred by the family to support messages to promote vaccination among parents/care givers. Since vaccines are available at health facilities, it is clear that the most important challenge is related to

utilization/demand. This study looked at clinically diagnosed measles rather than laboratory confirmed measles. There is therefore a possibility that some diagnoses of measles were actually other viral exanthems like rubella, scarlet fever, varicella and roseola. It was also hard to verify whether all the treatments/investigations documented in the charts were received by the patients. We instead assumed that they were received since they would ideally be required for management of these cases. However, in spite of these limitations, we believe our findings are valid and pertinent.

Conclusion

Mortality among children with measles was high and occurrence of complications was common with severe pneumonia being the commonest. The estimated average direct health care cost of treating a measles case in the National Referral Hospital was considerably high. Efforts are needed to promote immunisation against measles and related mortality and thus reduce costs to the healthcare delivery system.

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Data Availability

Data cannot be shared publicly as it contains confidential and potentially identifying patient information, and because they are the property of the Mulago National Referral Hospital. Request for data can be made to the Chairman School of Medicine Makerere University College of Health Sciences Institution Review Board (contact via: ponsiano.ocama@gmail.com, + 256772421190) for researchers who meet the criteria for access to confidential data.

Competing interests

The authors declare that they have no competing interests

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Author's contributions

All authors contributed to the design of the study, interpretation of results, reviewed, and approved the manuscript.

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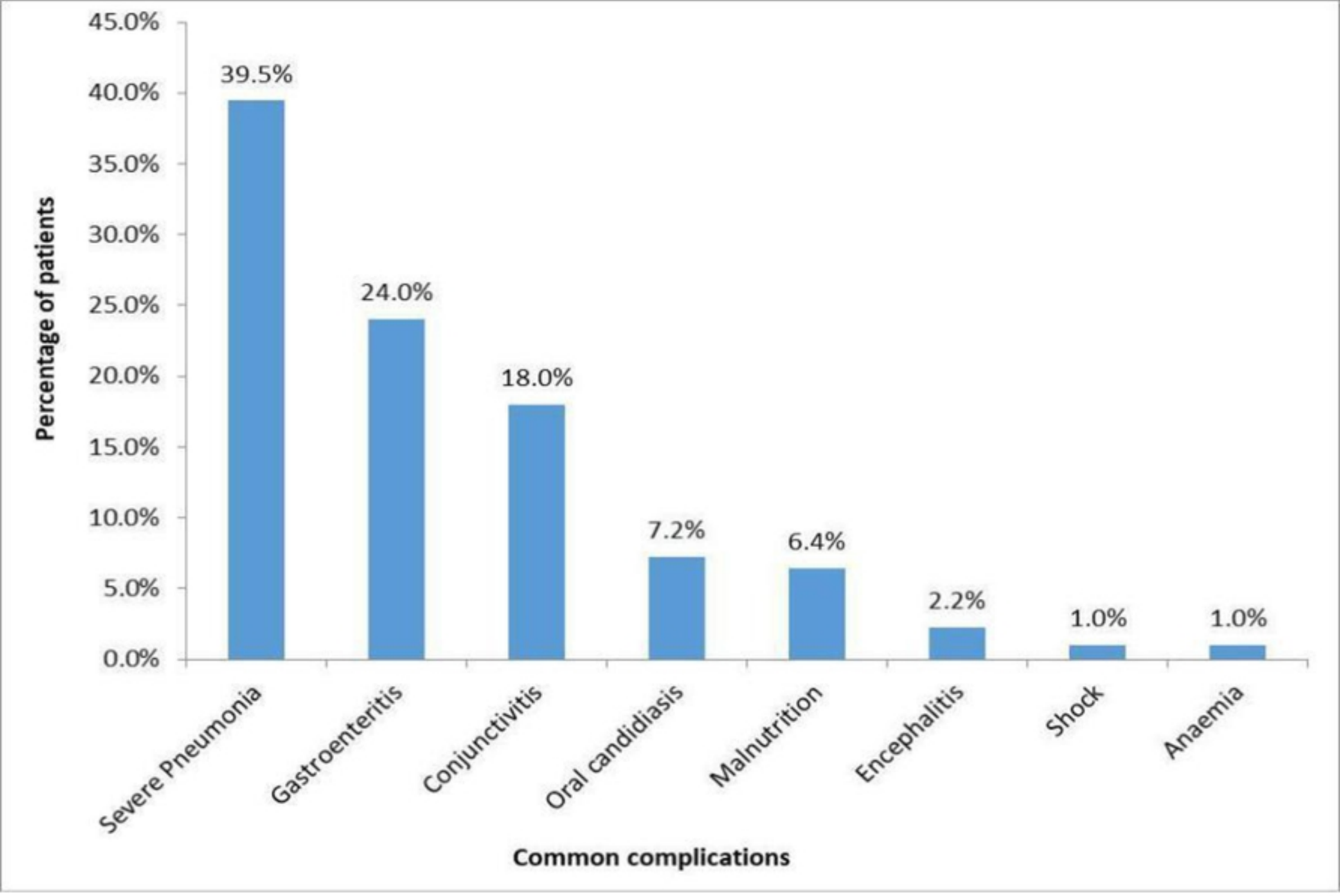
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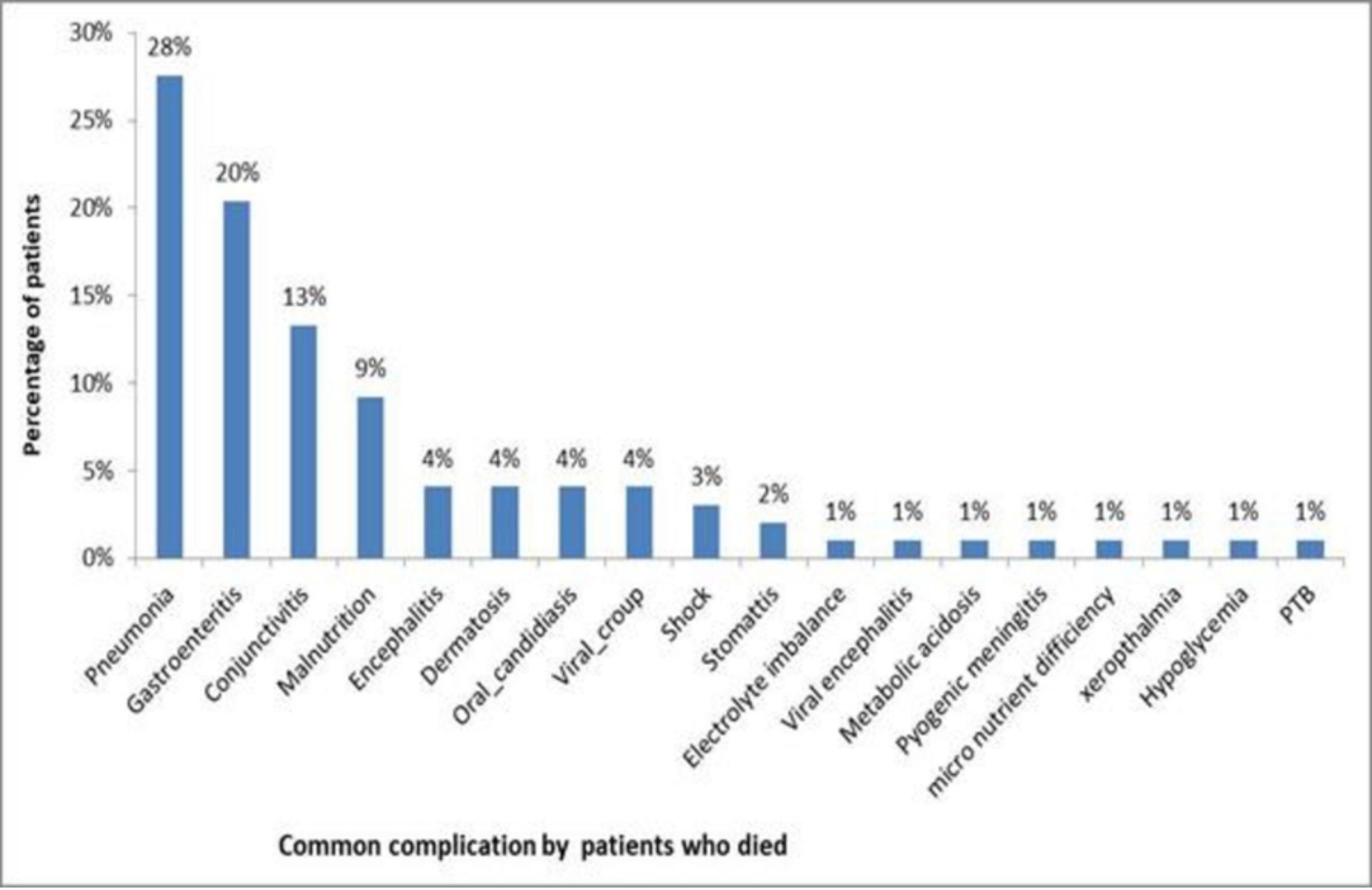
Figure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Electrolyte imbalance
Viral encephalitis
Metabolic acidosis
Pyogenic meningitis
micro nutrient difficiency
xeropthalmia
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PTB
Common complication by patients who died

Figure