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Original Research Article

Surge of healthcare associated infections in COVID intensive care units

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ABSTRACT

Background: Healthcare-associated infection played a vital role in determining the patient's outcome during the COVID pandemic. However, the data on HAI rates is largely unavailable in COVID locations. This is because conducting HAI surveillance inside COVID ICUs is a big challenge. Therefore, we conducted this unique quality improvement study which aims at comparing the trends of HAI rates in COVID and non-COVID ICUs during the ongoing pandemic.
Aim and Objective: The aim of the study was to compare the HAI rates in COVID and non COVID ICUs with the baseline HAI rates in pre COVID era.
Materials and Methods: The HAI surveillance was carried out during April 2020-December 2020 in the COVID ICUs (test group) and non-COVID ICUs (control group) and compared with ICUs from January 2019 to March 2020 (pre COVID baseline group). Then HAI data was analysed and the HAI rates were calculated based on national healthcare safety network guidelines.
Results: Overall, the HAI rates were higher in COVID time in comparison to pre COVID time. During the COVID period, higher HAI rates were seen in the COVID ICUs than in the non COVID ICUs. CLABSI rate had the highest occurrence followed by VAE, CAUTI, and SSI.
Conclusion: Higher HAI rates in COVID time indicates that there is need of serious infection control intervention thereby reducing the HAIs associated in COVID patients. Strict compliance to hand hygiene and other transmission-based precautions are to be followed in order to enhance the overall safety of patients.

1. Introduction

SARS-CoV-2, a novel strain of Coronavirus emerged in Wuhan, China, infected people of almost all age groups, alarmingly spread to various parts of world thereby making it a major health threat and subsequently declared as global pandemic by WHO.[1,2] It had a significant impact on people both in terms of health and economy.[3] Also, healthcare settings experienced a major crisis in terms of providing appropriate diagnosis and treatment of non COVID associated conditions.[4,5] In addition to this HAIs in COVID infected individuals also significantly affected the favorable outcome in the treatment of patients. Secondary bacterial infections are common as a sequel of respiratory viruses, and they act a major concern in management of patients with viral infections.[6]

Hospital Acquired Infections (HAIs) or nosocomial infections are a major adverse effect associated with

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treatment of patients and has a profound impact in patient safety.[7] HAIs are defined as an infection that occurs after 48 hours of admission and patient shouldn't be incubating for that infection at the time admission.[8] This may be attributed to prolonged hospital stay and use of hospital devices that pave a way for microorganisms to enter and infect the host. The most common HAIs are central line associated bloodstream infections (CLABSI), ventilator associated event (VAE), catheter associated urinary tract infection (CAUTI), and surgical site infections (SSI). HAIs are commonly associated with Multidrug Resistant Organisms (MDROs). The so called ESKAPE pathogens are attributed as common etiologic agents even though other agents like *Escherichia coli, Candida*, *Clostridioides difficile* etc. are also encountered.[9]

After the advent of COVID 19, it had profoundly influenced people of all sectors about the importance of hand hygiene and other transmission based precautions as they are simple and effective way of interrupting the transmission chain.[10] In spite of this, an overall increase in HAI rates have been observed. According to CDC, all HAI rates were drastically increased and the occurrence of Ventilator-associated pneumonia (VAP) also elevated during all the quarters of 2021. It also revealed increased occurrence of methicillin resistant *Staphylococcus aureus* (MRSA) and other MDROs. But a decline in hospital associated *Clostridioides difficile* infection was seen as there was an increased compliance to hand hygiene.[11] This implies the need of strong surveillance for HAIs in ICUs during the COVID period thereby helping us to implement appropriate intervention measures during the pandemic. However, conducting HAI surveillance inside COVID ICUs is a big challenge as it requires physical visit of personnel conducting surveillance inside the COVID ICUs. This is the reason why there is paucity of literature available on studying the HAI rates in COVID ICU and comparing with non-COVID ICUs. With this background, we conducted this unique quality improvement study which aims at comparing the trends of HAI rates in COVID and non COVID ICUs during the ongoing pandemic.

2. Materials and Methods

2.1. Study design and population

The study was a prospective, single centered cohort surveillance study, conducted at a large-scale tertiary care hospital located in South India. The study was carried out in 300 bedded multiple intensive care units (ICUs) of various departments covering various alliances of medicine and surgery from a tertiary health care center in South India. The surveillance was carried out in three groups over 2-time frames for the sake of comparative analysis.

1. COVID group (includes the COVID ICUs during the pandemic, i.e. April 2020 to December 2021): This is a test group, which provided the HAI rates in COVID ICU locations during the pandemic.
2. Non-COVID group (includes the non-COVID ICUs during the pandemic, i.e. April 2020 to December 2021): This acts as a control group, which provided the HAI rates in non-COVID ICU locations during the pandemic.
3. Pre COVID group (includes the ICUs from January 2019 to March 2020): This acts as a group which provided the base line HAI rates.

2.2. Methodology

The study intended to assess various HAI rates. The terminologies implicated in calculating and comparing of the test and control groups for various HAIs are VAE rate, CLABSI rate, CAUTI rate and SSI rate. The VAE, CLABSI, CAUTI and SSI rates are calculated as, per 1000 ventilator days, per 1000 central line days, per 1000 catheter days and per 100 surgeries respectively (Table 1), as CDC's National Healthcare Safety Network.[12,13] The HAI surveillance was performed by trained infection control nurses (ICNs) of hospital infection prevention and control (HICP) unit, as a part of their routine protocol. They used to visit the surveillance locations daily and collect clinical data and culture reports prospectively of patients on medical devices (e.g. urinary catheter, central line or ventilator) or post-operative surgical site wound care to establish the diagnosis of HAI criteria (Table 1). Two types of forms were used to collect the data of HAI surveillance. A numerator form or a structured HAI surveillance proforma was used to record both clinical and microbiological information that are required to satisfy the criteria of HAI. A denominator form (also called 'daily appraisal form') was used to collect the data required for the denominator for determining HAI rates such number of days on medical devices and number of surgeries performed etc. Finally, the data collected were entered in an excel sheet and analyzed to calculate these four HAI rates. Subsequently, the monthly report of the location wise data was generated which was then cumulatively analyzed over the defined time frame. The same protocol is followed in all the ICU locations over all the two-time frames. However, the ICNs used to strictly adhere to the COVID personal protective equipment (PPE) protocol during their visit into the COVID ICUs along with appropriate donning and doffing protocols.[13] The statistical analysis was done using SPSS version 27 software (IBM-SPSS Inc, Armonk, NY).

3. Results

The overall prevalence of HAI rates in COVID, non-COVID and pre-COVID groups has been depicted in Figure 1. All the four types of HAI rates were found to be higher in COVID ICUs, followed by the control (non-COVID ICUs)

Table 1: Formula used for the calculation of various HAI rates [12,13]

Terminologies	Formulae
VAE rate	Number of VAE cases/total number of ventilator days×1000
CLABSI rate	Number of CLABSI cases/total number of central line days×1000
CAUTI rate	Number of CAUTI cases/total number of catheter days×1000
SSI rate	Number of SSI/number of surgeries done×100

CLABSI: Central line associated bloodstream infections; VAE: Ventilator associated event; CAUTI: Catheter associated urinary tract infection; SSI: Ssurgical site infections

and baseline (pre-COVID) groups. Of those, CLABSI rate was 31.09 (137/4407) per 1000 central line days, being the highest in COVID group. VAE rate was found to be 28.01 (103/3677) per 1000 ventilator days and CAUTI rate was 5.14 (36/7007) per 1000 catheter days in the COVID group—higher than that of non-COVID and pre-COVID locations. The SSI rate in COVID group was found to be 4.82% (4/83), which had only a minor fall when compared to the control and baseline groups. Figure 2 shows the quarterly trend analysis of CLABSI rates in COVID and non-COVID ICUs. The highest CLABSI rate in COVID ICUs was seen during the period of October-December 2020 and during April-June 2021 due to the increased number of admissions of COVID infected patients. A fall was observed during the period of January 2021 to March 2021 in COVID ICUs which may be attributed to the reduced number of patient admissions whereas the patient admission was almost uniform in all non-COVID ICUs during the entire time period. Figure 3 depicts the trend of VAE rates in COVID and non-COVID control groups. High VAE rates were seen in COVID ICU group in comparison to non-COVID ICUs. The VAE started to decline over the period of October 2021 - December 2021 in COVID ICUs. The trend in non-COVID ICUs was stable during the entire time period. Figure 4 represents the CAUTI rate in COVID and non-COVID control groups. The CAUTI rates were higher in COVID ICUs than in non-COVID ICUs. Here also a similar decline was seen during the period of October 2021 to December 2021 in COVID ICUs due to reduced number of COVID cases admitted at that point. Figure 5 shows the SSI rate in COVID and non-COVID control groups the quarterly trend of SSI rates in the COVID was found to be similar to that of non-COVID ICUs, except that there was a peak seen during the period of January-March 2021 in COVID ICUs.

4. Discussion

HAIs are common consequences in critically ill bedridden patients. The occurrence of HAI in COVID patients complicated the situation more in addition to the ongoing pandemic. The major outcome of our study was that the three important HAI rates (CLABSI, VAE and CAUTI) were high in COVID ICUs than in non COVID patients and the pre COVID era and the differences among the HAI rates between COVID vs. non-COVID; and COVID vs. pre-COVID groups were found to be statistically significant ($p < 0.05$). In concordant to our result, there were several studies which reported similar finding of the increase in HAI rates between COVID and non-COVID groups ranging from 7.2% to 46%. All these studies described that COVID infected individuals had secondary bacterial of fungal infections predisposing them to use of mechanical devices, which led to HAI. [14–18]

Of the HAI rate we have analyzed in COVID ICUs, the highest HAI rate reported was CLABSI rate – 31.09 (137/4407). The main reason for this can be attributed to the high incidence of secondary bacteremia or candidemia in these group of patients. As a result, a central line was needed to administer intravenous antibiotics or antifungals which in turn led them to acquire nosocomial infections. A meta-analysis proposed by Langford et al. illustrated that bacterial coinfections were more common in COVID infected patients than in non COVID infected patients. [19] Previous studies done by Lansbury et al. and Buetti et al showed increase rates of CLABSI due to bacterial super infection. [20,21] The primary reason proposed for this is the increased use of immunomodulatory therapies (monoclonal antibodies) in COVID 19 such as tocilizumab etc. A randomized control trial by Somers et al. showed patients on treatment with tocilizumab had high incidence of CLABSI rates. [22] But other two studies by Salvarani et al. and Hermine et al. showed no association between usage of tocilizumab and bloodstream infections in spite of CLABSI rates being higher. [23,24] Other possible causes can be due to the gastrointestinal manifestations associated with COVID 19 led to mucosal breach and involvement of normal GI flora in blood stream of patients resulting in sepsis. [25,26] Another possible reason is the due to the immunosuppressive nature of SARS-CoV-2, an immune dysregulation happens which is mediated by increased production pro-inflammatory cytokines like IL-6 which in turn leads to CD4 and B cell lymphopenia. [27] Also, due to overload of patients more than the normal capacity, the strict adherence to care bundle may not be followed while administering central line and there was also a delay or demand in the procurement of PPE as the logistics were severely affected during COVID period. HCWs were found to don gloves continuously in COVID ICUs resulting in poor compliance to hand hygiene in between the patients, which could have been the main factor responsible for increased HAI rates in COVID locations. [28,29]

VAE rates were the second highest HAI in COVID ICUs in our study 28.01 (103/3667). The VAE rate in

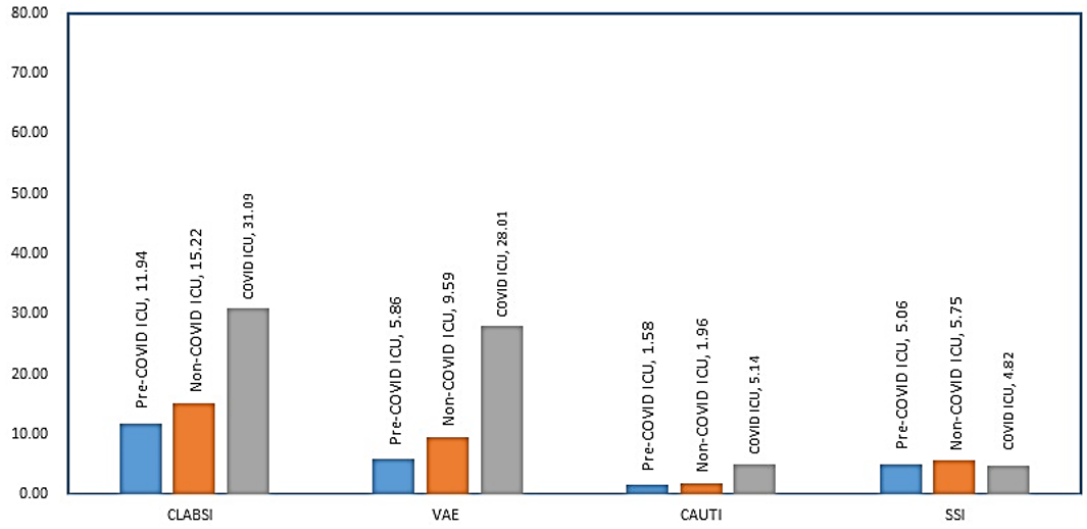

Figure 1: Prevalence of healthcare associated infections in COVID and non-COVID ICUs in comparison with Pre COVID era Note, the blue colored bar graph depicts the HAI rates during the pre COVID period of January 2019 - March 2020. The orange-colored bar graph depicts the HAI rates in the non COVID ICUs during the period of April 2020 - December 2021. The grey-colored bar graph depicts the HAI rates in the COVID ICUs during the period of April 2020 - December 2021.

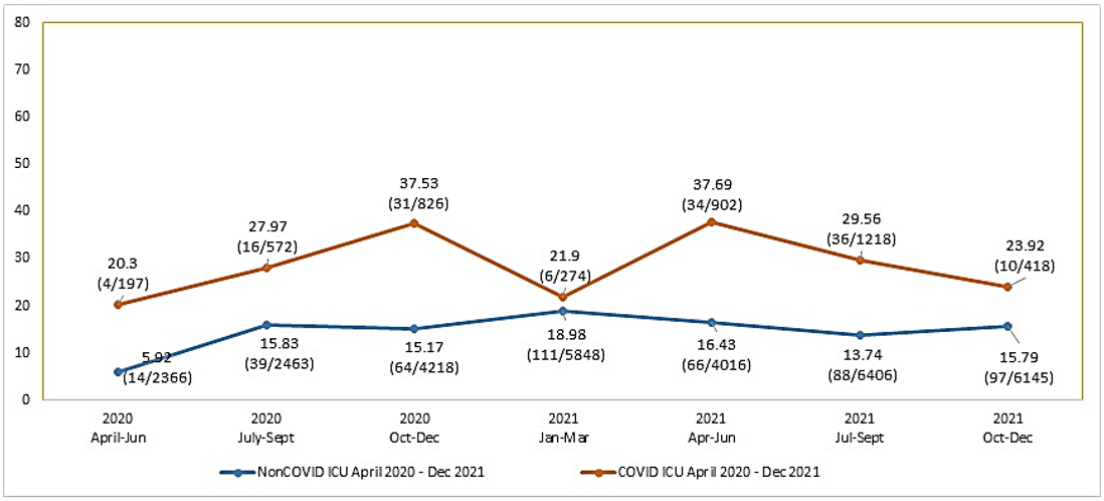

Figure 2: Trend analysis (quarterly) of CLABSI rates COVID-19 and non-COVID control groups

COVID ICUs was found to be higher than in non-COVID and pre-COVID groups (statistically significant, $p<0.05$). In comparison to non-COVID ICUs, the increase in VAE rate can be accounted for increased need of mechanical ventilation in COVID ICUs. Also, a decline was noticed during the period of October- December 2021 in COVID ICUs which could be due to the reduced admission of COVID infected patients at that point. Being a respiratory virus, SARS-CoV-2 has various mechanisms that lead to respiratory distress such as reduced lung parenchyma compliance, impaired alveolar gaseous exchange and exaggerated host immune response that leads to respiratory epithelial damage etc. which predisposes to the need of mechanical ventilation.[30] COVID patients required more time of mechanical ventilation in comparison to patients with other ailments as it is primarily a respiratory illness. Prolonged time and increased need of ventilator makes COVID patients liable to acquire VAP. A similar finding was seen in some studies where the same reason is defined for increased VAE rate.[31–33] Other host factors such as age, related co-morbidities can also contribute to this. This can be overcome by deciding the absolute need of mechanical ventilation only when it is indicated and following all steps of care bundle to overcome the increased VAE rates.[32]

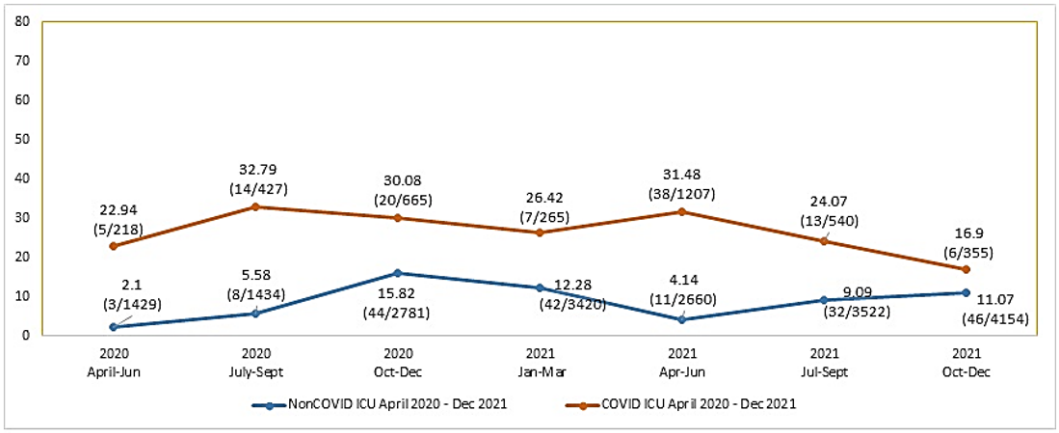

Figure 3: Trend analysis (quarterly) of VAE rates COVID-19 and non-COVID control groups

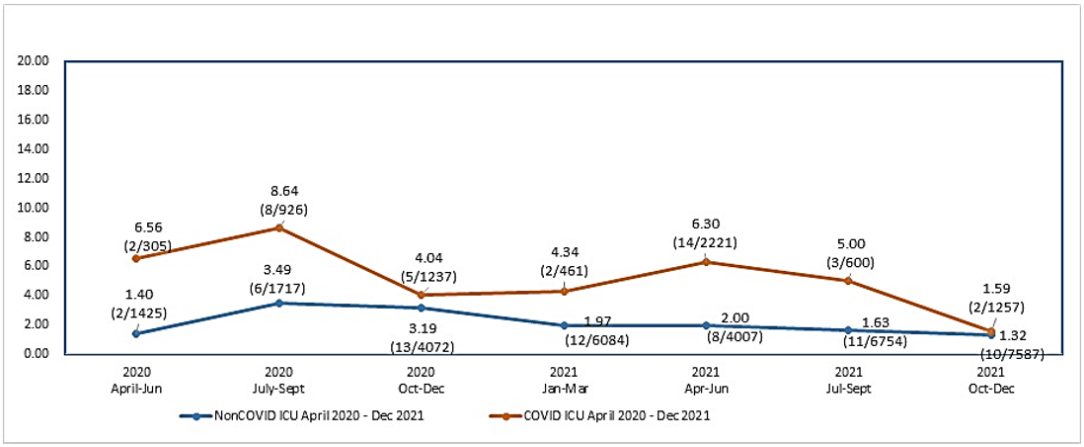

Figure 4: Trend analysis (quarterly) of CAUTI rates COVID-19 and non-COVID control groups

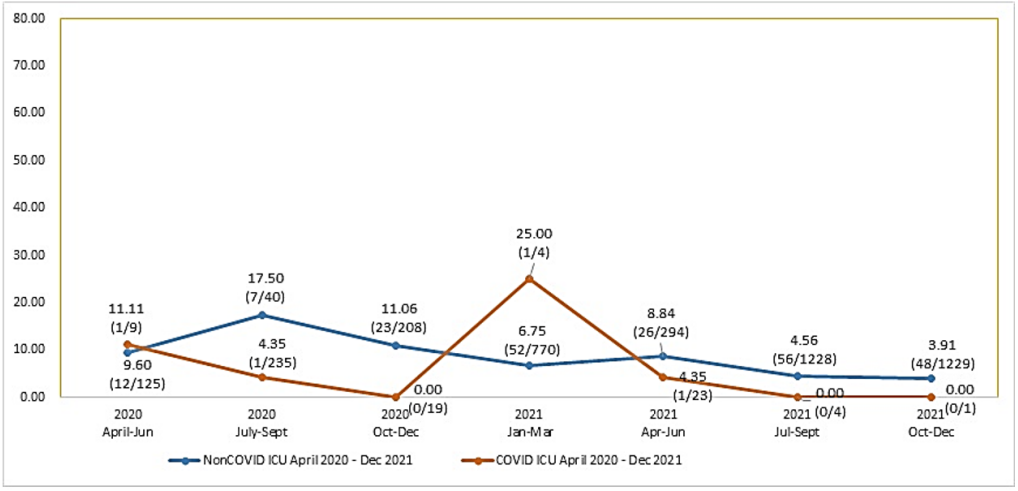

Figure 5: Trend analysis (quarterly) of SSI rates COVID-19 and non-COVID control groups

CAUTI rate was also found to be increased in COVID ICUs than in non-COVID and pre-COVID ICUs (statistically significant, $p<0.05$). The increased rate may be due to the fact that most of critically ill COVID infected patients were either with central line or under ventilator making them a strain to move. As a result, they were catheterized for voiding. This led them to acquire CAUTI and increased the CAUTI rate. A similar finding was noted by Hyte et al. where there was an increased rate of CAUTI in COVID. In the surge of COVID, due to short staffing, a person from non-critical area is forced to work in a critical care area where the person is poorly trained which can lead to poor adherence to care bundle and transmission-based precautions.[28] But many other studies showed contraindicating outcomes, where there was a decline in CAUTI rate during the COVID time.[34–37] Even though the reasons for this is not clear various possibilities are proposed. The COVID infected patients were receiving high doses of antibiotics for their secondary bacterial infections which would have obscured the occurrence of CAUTI.[34,38] Screening of urine samples were not regularly done to cut down the possibility of acquiring SARS-CoV-2.[34]

SSI had only a minor decrease in the rate in COVID patients in comparison to non-COVID and pre-COVID patients (statistically insignificant, $p>0.05$).

In contrast to other HAI indicators, the SSI had a different course of trend. The SSI rate between COVID, non-COVID and pre-COVID groups were found to be similar, with a slightly higher SSI rate in non-COVID group (statistically insignificant, $p>0.05$). The primary reason could be due to reduced intake of elective surgical procedures during the COVID time and lesser requirement of COVID patients for any surgical intervention. In contrast, the non-COVID locations were found to carry out a higher number of surgeries, and therefore were more prone to develop SSI. A similar finding was noted in some studies where they proposed that strict adherence to pre and perioperative surgical precautions has led to decreased SSI rates.[39–42] On the other hand, certain studies showed zero correlation between the occurrence of SSI and COVID.[43–45] A peak in SSI rate in COVID group was seen during January-March 2021, which may not be significant as the sample size as too low (1 SSI out of four surgeries) to arrive at a meaningful comparison.

Overall, our study demonstrated an increase in rates of nosocomial infections in COVID infected individuals in comparison with non-COVID and pre-COVID groups. The reasons contributing for increase in HAIs were prolonged hospital stay, increased need of medical devices in treatment of COVID patients, immune status of COVID infected individuals and the level of adherence to care bundle and hand hygiene. This study shows a paradoxical effect between importances of hand hygiene, other transmission-based precautions and COVID 19. A minor decrease in SSI rate may not be significant because of reduced number of elective surgeries during COVID time.

5. Conclusion

Overall, the study revealed an overall increase in the HAIs rates especially with CLABSI during the COVID time. Although there was an increased knowledge and compliance towards hand hygiene and other precautions in the fear of COVID, the HAI rates continued to rise. The only beneficial outcome during this period was a reduction in the SSI rates due to strict adherence to surgical precautions. Further studies can be done to evaluate the etiological agents involved in HAIs which gives a better idea for deciding pathogen-directed control measures in the future. Hence serious surveillance for HAIs to be done routinely and adherence to care bundle is to be strictly monitored to overcome this.

6. Source of Funding

None.

7. Conflict of Interest

None.

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