Comparison of Patients Undergoing Tracheostomy in the Intensive Care Unit versus in the Wards

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ABSTRACT **Background:** In Israel, critically ill patients are ventilated and managed in intensive care units or general wards.

Objectives: To compare the mortality rates and long-term cognitive and functional outcomes of ventilated patients who underwent tracheostomy insertion in the Medical ICU (MICU) versus those cared for in the in-patient wards.

Methods: The study comprised 170 patients who underwent percutaneous dilatational tracheostomy (PDT) over an 18-month period in the MICU (n=102) and in in-patient wards (internal medicine and neurology) (n=68). Telephone interviews were conducted with living patients and/or their relatives at least 6 months after discharge from the hospital.

Results: Ward patients were 10 years older than ICU patients undergoing PDT (P = 0.003). The length of stay (LOS) in the wards was longer than in the ICU (P < 0.001), whereas the total LOS in the hospital was similar (P = 0.43). ICU mortality was lower than in the wards (P = 0.001) but hospital mortality was comparable between the two groups (P = 0.17). At 6 months follow-up more ICU patients were fully conscious, weaned from ventilation, and decannulated. More patients in the ICU group were at home and were independent or had mildly impaired activities of daily living. More patients in the ward group were residing in long-term care facilities with functional limitations.

Conclusions: MICU patients who undergo tracheostomy may have a good long-term functional and cognitive outcome. More studies are needed to further assess long-term outcomes in these patients.

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Beds in intensive care units (ICUs) are limited throughout the world, including Israel. In Europe, the number of ICU beds per 100,000 inhabitants is 11.5 (range 4.2–29.2) [1] whereas in Israel there are only 7.5 ICU beds per 100,000 inhabitants [2]. Critically ill patients presenting to the hospital are therefore triaged, according to numerous protocols: to either the intensive care unit (ICU) or the general ward [3]. Some of the triage factors assessed are age, baseline status, and proposed/estimated chance for short- and long-term survival and recovery. Complexity of illness also plays a role in decision-making. These triage decisions are made daily in various hospitals in Israel [4,5], which already have established wards to accommodate ventilated patients.

The Medical Intensive Care Unit (MICU) at the Hadassah University Medical Center, Jerusalem, Israel, treats critically ill patients with, cardiac, respiratory, neurological, hemato-oncological, renal, liver, and other non-surgical diagnoses. Most patients have pre-existing chronic illnesses, reducing their potential for full recovery. Patients who are deemed to have poorer outcomes based on initial triage, are ventilated instead in the medical or neurological wards. In both patient populations (in the ICU and on the medical or neurology wards), a percutaneous tracheostomy is performed in patients who fail extubation and are not expected to be weaned within a reasonable amount of time (typically 10–14 days) to facilitate long-term and/or chronic ventilation [6].

Due to legal constraints in Israel, ventilation cannot be withdrawn from patients who are ventilator-dependent and those who survive their hospital admission are often chronically ventilated in the medical wards or in chronic care facilities. Elderly patients, patients with multiple chronic diseases, and patients with neurological or muscle weakness may require prolonged ventilation [3,7]. Prolonged ventilation refers to the need for mechanical ventilation for more than 21 days, for more than 6 hours per day [7]. Due to improved ICU care and therefore, increased survival in ICU patients, the number of patients who require prolonged mechanical ventilation (PMV) and tracheostomy, is rising [6,8,9] and is estimated at 3–9% of patients ventilated in ICUs [10]. Between 30 and 50% of these chronically ventilated patients will be weaned from ventilation during their initial stay in an acute care facility [11]. However, patients who do not wean within 60 days have a smaller chance of weaning later on [11]. These patients may be transferred to specialized weaning centers, which may improve their chances of weaning from mechanical ventilation. These centers require specialized infrastructure and multi-disciplinary teams [10].

In patients who receive PMV, the 1-year mortality has been described as high as 50–60% [11-14]. As these patients are hospitalized in different levels of care, including acute care facilities, weaning centers, and chronic ventilation centers, the long-term outcome is difficult to determine, but is generally poor [10,11]. Longer term outcomes are mainly dependent on diag-

nosis at admission, functional reserve, and complications during the admission [15,16]. Many patients show brain dysfunction [17] resulting in reduced functional and cognitive capacity [13]. Many of these patients complain of pain, distress, and lack of energy [18], indicating poor quality of life.

In this study, we compared the mortality rates and long-term cognitive and functional outcomes of ventilated patients who were admitted to and underwent tracheostomy insertion in the MICU versus patients cared for in the in-patient wards.

PATIENTS AND METHODS

Ethics approval for the study was obtained from the Hadassah Helsinki committee (0116-14-HMO). We prospectively collected data from 170 patients who underwent PDT over an 18-month period in the MICU and in in-patient wards (internal medicine and neurology). Of note, the tracheostomy procedure is performed by the same intensive care specialists, whether the procedure is performed in the wards or in the ICU. Clinical and demographic data were collected from patient medical records and they were followed for a minimum of 6 months after discharge. Data collected included demographic parameters (age and gender), clinical parameters (ventilation mode and duration, inotrope use and cognitive function), and ICU, hospitalization, and long-term outcome. Phone interviews were conducted with living patients and/or their relatives at least 6 months after discharge from the hospital. A telephonic questionnaire was used to gather information about cognitive and functional outcomes including need for ventilation, need for tracheostomy, level of consciousness, and recent hospital admissions. Quality of life was evaluated using the SF-12 score, which evaluates both mental and physical health perceptions [19,20].

A comparison was made between outcomes MICU of patients (n=102, 60%) and patients in in-patient wards (n=68, 40%) who had undergone PDT. The groups were compared using several fields: clinical state during hospitalization, admission, and ventilation intervals. Comparison of categorical parameters was performed using Chi-square and Fisher's exact tests. Continuous variables were compared using Student's *t* and Mann–Whitney tests. Survival between groups was compared using Kaplan–Meier curves. The patients who were interviewed via phone (n=42) were asked about current ventilation requirements, place of residence, main caregiver, presence of bedsores, and cognitive and functional status.

RESULTS

A total of 170 patients were analyzed: 102 patients from MICU and 68 patients from the wards [Table 1].

The patients undergoing tracheostomy in the wards were older by 10 years than the patients undergoing tracheostomy in MICU ($P = 0.003$). LOS in the wards was longer than in the ICU (18.5 vs. 43 days, $P < 0.001$). This association is complex as the patients awaiting transfer to a long-term ventilation facility generally wait in the wards until a bed becomes available in the facility. This includes patients transferred from the ICU to continue treatment and/or to wait for transfer to a long-term ventilation facility. Length of ventilation (LOV) before and after tracheostomy and total length of stay in the hospital were similar between the two groups.

Short-term complications (bleeding, infection, mis-placement of the cannula, arrhythmias, cardiopulmonary resuscitation or death) of the PDT procedure were similar between the two groups.

Regarding admission diagnoses, Table 1 shows that a significantly higher proportion of patients admitted to the ICU suffered from complex respiratory conditions and as a result, may have required more complicated mechanical ventilation (chronic obstructive pulmonary disease [COPD], asthma, acute respiratory distress syndrome, interstitial lung disease) compared to patients admitted to the wards. Patients post resuscitation were more often admitted to the wards probably due to a worse predicted outcome.

Regarding background medical conditions, the patients admitted to the ICU had more chronic respiratory illnesses (COPD, asthma, interstitial lung disease) whereas the patients admitted to the wards had more cardiac diseases. As expected, a higher percentage of patients in the wards had dementia vs. the MICU. In the ICU there were more patients with solid organ malignancy and immunosuppression. These patients are normally treated in the hemato-oncology wards where ventilation is not performed and are therefore transferred to the ICU [Table 2].

Comparison of patient outcomes is shown in Table 2. The overall mortality in ICU was lower than in the wards (10.8% vs. 30.9%, $P = 0.001$). Hospital outcome was not significantly different (41.2% vs. 30.9%. $P = 0.17$). There was no significant difference between the number of patients weaned from ventilation at discharge, but more patients from the ICU group were decannulated (6 vs. 0, $P = 0.003$).

Cognitive function on discharge may be divided into a few groups: fully conscious, somnolent, minimally conscious, and comatose state [Figure 1]. More patients discharged from the ICU were fully conscious (58.3% vs. 36.2%, $P = 0.02$).

Survival was evaluated both overall and post discharge from the hospital. No difference in 28 day (88.3% vs. 87.2%, $P = 0.86$), 90 day 81.7% vs. 70.2%, $P = 0.18$), 6 month (71.7% vs. 66.0%, $P = 0.45$), or 1 year (45.0 % vs. 38.2%, $P = 0.70$) survival was demonstrated between the two groups. In addition, post-discharge survival was not statistically different between the two groups (66.7 vs. 55.3, $P = 0.2$) [Table 3].

For the prospective part of the study [Table 3], 42 of the patients (or their family members) were contacted telephonically to enquire about their functional and cognitive situation. The rest of the patients (65 patients) were not interviewed as the

Table 1. Patient demographic and outcome data

	MICU (n=102, 60%)	Wards (n=68, 40%)	*P* value*
Age (years) Mean ± SD Range	65.2 ± 16.5 17–90	73.0 ± 15.7 23–96	**0.003**
Gender (% females)	37.3	48.5	0.14
LOS in department (mean, days)	18.5	43.0	**< 0.001**
LOS in hospital (mean, days)	54.8	51.3	0.43
Ventilated before PDT (%)	94.1	85.3	0.054
LOV before PDT (mean, days)	12.7	15.1	0.10
Short-term complications following PDT (in 24 hours), %	9.8	9.0	1.0
LOV after PDT (mean, days)	25.7	27.0	0.74
Total LOV (mean, days)	38.6	41.9	0.49
Diagnosis on admission			
Pneumonia (%)	46.1	54.4	0.29
COPD/asthma exacerbation (%)	15.7	1.5	**0.002**
Interstitial lung disease/ARDS (%)	11.8	0.0	**0.002**
Other respiratory (PE) (%)	2.9	1.5	0.65
Cardiac (%)	11.8	19.1	0.19
CPR (%)	7.8	19.1	**0.03**
Neurological (CVA, trauma, anoxic brain damage) (%)	29.4	26.5	0.68
Sepsis/infection (%)	23.5	35.3	0.10
For weaning/elective admission (%)	5.9	1.5	0.25
Metabolic (%)	4.9	0.0	0.16
Renal (%)	3.9	2.9	1.0
Gastrointestinal/liver (%)	3.9	2.9	1.0
Trauma/surgery (%)	2.9	2.9	1.0
Other (%)	2.9	2.9	1.0

*Bold indicates significance
ARDS = acute respiratory distress syndrome, COPD = chronic obstructive pulmonary disease, CPR = cardiopulmonary resuscitation, CVA = cerebrovascular accident, LOS = length of stay, LOV = length of ventilation, PDT = percutaneous dilational tracheostomy, PE = pulmonary embolus, SD = standard deviation

Table 2. Patient outcomes

	MICU (n=102, 60%)	Wards (n=68, 40%)	*P* value*
Primary department mortality, n, (%)	11 (10.8)	21 (30.9)	**0.001**
Hospital mortality, n, (%)	42 (41.2)	21 (30.9)	0.17
Weaned from ventilation on discharge from the hospital, n, (%)	30 (29.4)	19 (27.9)	0.84
Decannulated on discharge, n, (%) of discharged patients	6 (10.0)	0 (0.0)	**0.03**
Fully conscious on discharge, n, (%) of discharged patients	35 (58.3)	17 (36.2)	**0.02**
Overall mortality at follow-up, n, (%)	66 (64.7)	46 (67.6)	0.69

*Bold indicates significance

Table 3. Cognitive and functional outcomes at time of interview

Outcomes	MICU (n=25)	Wards (n=17)	*P* value*
Follow-up time (days)			
Mean ± SD Median Range	498.2 ± 206.6 526 218–879	471.7 ± 168.4 456 222–777	0.72
Mechanically ventilated at follow-up time, n (%)	8 (32.0)	13 (76.5)	**0.005**
Existing tracheostomy tube, n (%)	9 (36.0)	14 (82.4)	**0.003**
Residence			
Home Nursing home Rehabilitation Hospital	20 (80.0) 1 (4.0) 0 (0.0) 4 (16.0)	6 (35.3) 2 (11.8) 1 (5.9) 8 (47.1)	**0.008****
Main caregiver			
Independent Family Foreign worker Facility staff	5 (20.0) 8 (32.0) 7 (28.0) 5 (20.0)	1 (5.9) 2 (11.8) 3 (17.6) 11 (64.7)	**0.04****
Independent or impaired in ADL	15 (60.0)	2 (11.8)	**0.002**
Fully conscious	17 (68.0)	4 (23.5)	**0.005**
Decubitus ulcers	4 (16.0)	1 (5.9)	0.63
Home admission (*ishpuz bayit*)	8 (32.0)	4 (23.5)	0.73

*Bold indicates significance
**Overall group
ADL = activities of daily living, SD = standard deviation

team was unable to reach them, there was a language barrier, or they refused to participate due to personal reasons.

The family members were asked numerous questions regarding the patient's medical condition at the time of the interview.

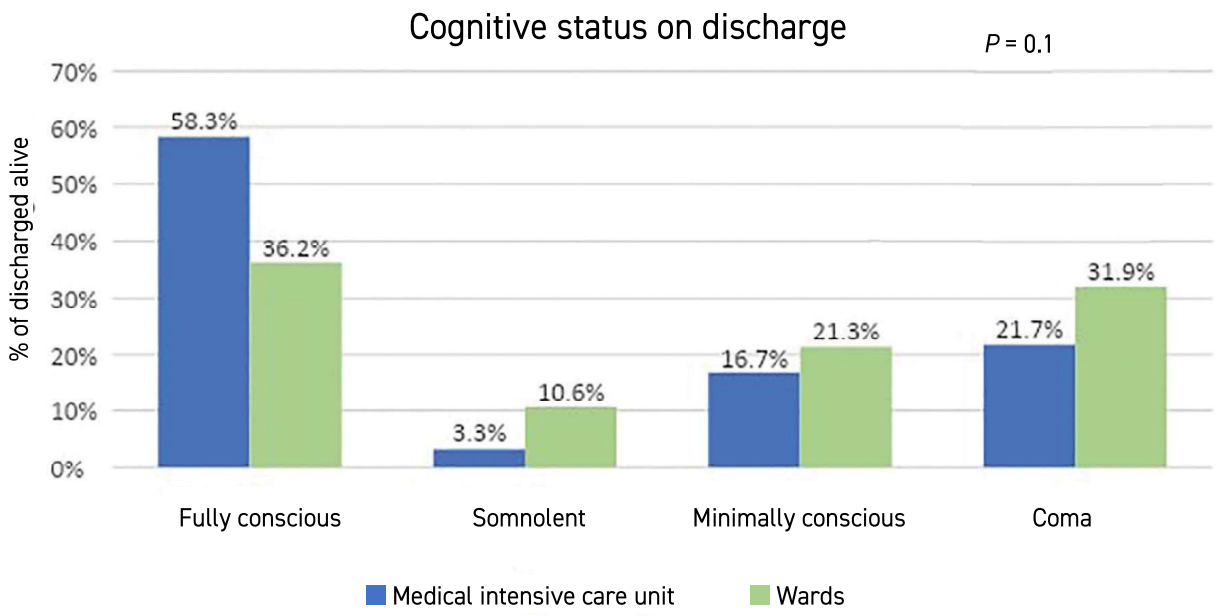
The mean follow-up of patients was at 487 days (1 year and 4 months). Significantly more patients in the ward group still required mechanical ventilation, whereas significantly more patients in the ICU group had undergone decannulation (64% vs. 17.6%, $P = 0.003$).

Table 3 shows that significantly more patients in the ICU group were residing at home at the time of the interview, whereas more patients in the wards group were residing in care facilities (nursing home, rehabilitation unit, or hospital). The same was true regarding the primary caregiver. More patients in the ICU group were independent or cared for by their family members, whereas the patients from the wards were treated by caregivers at the treatment facility. Significantly more patients in the ICU group were independent or had impaired activities of daily living, whereas more patients in the wards group were dependent on a wheelchair or were fully bed bound (60% vs. 11.8%, $P = 0.002$). The number of decubitus ulcers, home admissions, and overall admissions were low and there was no significant difference between the groups.

Significantly more patients in the ICU group were fully conscious on discharge [Figure 1]. Further analysis was performed to determine whether this was a factor or a confounder. The connection between this variable and the place of admission is complex and therefore logarithmic regression was used. We found that among the long-term outcomes, being fully conscious on discharge is the only factor associated with being fully conscious at the time of follow-up. (adjusted hazard ratio = 11.5, 95% confidence interval 2.3–57.9). In addition, full consciousness on discharge was found to be a contributing factor (in addition to the place of admission) to being without a tracheostomy and improved functional status at the time follow-up was performed.

A questionnaire (SF 12) was sent to the cognitively stable patients to self-evaluate their health status. Nine questionnaires were received from the MICU group during the study but only one from the ward group. For this reason, no statistical analysis was possible. From the answers to the questionnaire it was clear that the patients' quality of life was mainly dependent on their physical well-being, which affects their daily functioning, as well as socially. Few patients reported pain but nearly half of the respondents reported feelings of depression and sadness.

Figure 1. Cognitive status on discharge from hospital



DISCUSSION

This single center study was performed in order to better understand the differences between patients undergoing PDT in the ICU versus those in the medical and neurology wards. Demographically, the patients in the ward group were older by almost a decade when compared to patients in the ICU group. The ICU length of stay was shorter than the length of stay of patients in the ward group. This result is because patients are transferred out of the ICU as soon as they stabilize due to a limited number of ICU beds. Patients await transfer to long-term ventilation facilities in the in-patient wards. The overall length of stay in hospital (including ICU) was just over 50 days, similar in the two groups. These findings were similar to previously published data from Israel [4,9,21].

The mean time patients were ventilated prior to tracheostomy was similar between the groups as was the short-term complication rate of tracheostomy. This is because the same ICU doctors perform the procedures both in the ICU and outside the ICU and generally the same criteria for tracheostomy insertion are applied to all patients.

The patients admitted to ICU had a better expected prognosis and higher baseline functional capacity. More patients with complex respiratory illnesses were admitted to the ICU as well as immunocompromised patients, as they require more specialized care and closer monitoring.

The overall hospital mortality was similar between the groups. This was surprising given that the patients in the ICU group were assessed as having a better prognosis. However, the patients in the ICU group were more complicated patients with multi-organ failure (mean APACHE II 25.6 ± 8) who would most likely not have survived without the ICU. Therefore, there is a balance between the disease severity and the intensity of treatment, which results in similar mortality rates. Also, due to limited places available in chronic care facilities, patients often develop complications while awaiting transfer to these facilities.

The overall mortality at follow-up (mean 487 days) of over 60% in both groups reflects trends in the data from other centers reflecting a 1 year mortality of 36–60 % for these patients [13,14].

Two important observations: only patients in the ICU group were decannulated during their hospital stay and more patients in the ICU group were discharged in a better cognitive state. In other words, the patients in the ICU group were discharged in an overall better state. This finding reflects the initial selection bias of admitting younger patients with better expected prognosis to the ICU. This result was also reflected in the long-term follow-up as more patients in the ward group remained on chronic ventilation (i.e., more patients in the ICU group were weaned). More patients in the ICU group were able to be cared for at home. This finding is important due to the reservations against performing tracheostomy in complex medical patients admitted to the ICU, which may not be justified, as some patients have a reasonable long-term functional and cognitive outcome.

LIMITATIONS

This study has the following limitations: First, it is a single-center study. Protocols and practices vary among institutions. The study was performed in Israel where there is greater access to long-term ventilation. Second, during the follow-up, patients who chose to answer the questionnaire were in a better overall state of health than those who did not. As the opinions of the patients and/or their caregivers were obtained, these opinions are purely subjective. Patients with a more positive outlook would generally give a more favorable answer.

CONCLUSIONS

In this single-center study, performed in Israel where patients may be ventilated in the medical / neurological wards as opposed to only in ICU units, and where patients may not be disconnected from ventilation as part of end-of-life decisions, tracheostomy may be performed to facilitate long-term ventilation. Patients in the wards had an unfavorable long-term prognosis, remained dependent on long-term ventilation and had a poor quality of life. However, patients who underwent tracheostomy in the ICU had a greater chance of weaning and better quality of life. More studies are required to assess predictors for a good respiratory and neurological outcome in this group of patients.

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References:

1. Rhodes A, Ferdinande P, Flaatten H, Guidet B, Metnitz PG, Moreno RP. The variability of critical care bed numbers in Europe. *Intensive Care Med* 2012; 38 (10): 1647-53.
2. Israel Health Ministry Bed Statistics 2020 [Available from https://www.health.gov.il/UnitsOffice/HD/MTI/info/Pages/licensed_inpatient_hospital_beds.aspx]. [Accessed 10 June 2020].
3. MacIntyre NR, Epstein SK, Carson S, Scheinhorn D, Christopher K, Muldoon S. Management of patients requiring prolonged mechanical ventilation: report of a NAMDRC Consensus Conference. *Chest* 2005; 128 (6): 3937-54.
4. Izhakian S, Buchs AE. Characterization of patients who were mechanically ventilated in general medicine wards. *IMAJ* 2015; 17 (8): 496-9.
5. Hersch M, Sonnenblick M, Karlic A, Einav S, Sprung CL, Izbicki G. Mechanical ventilation of patients hospitalized in medical wards vs. the intensive care unit—an observational, comparative study. *J Crit Care* 2007; 22 (1): 13-7.
6. Carey TS, Howard A, Carson SS, Holmes GM, Cox CE. Increase in tracheostomy for prolonged mechanical ventilation in North Carolina, 1993–2002. *Crit Care Med* 2016; 32 (11): 2219-26.
7. Carsen SS. Definitions and epidemiology of the chronically critically Ill. *Respir Care* 2012; 57 (6): 848-58.
8. Zilberberg MD, De Wit M, Pirone JR, Shorr AF. Growth in adult prolonged acute mechanical ventilation: Implications for healthcare delivery. *Crit Care Med* 2008; 36 (5): 1451-5.
9. Zisk-Rony RY, Weissman C, Weiss YG. Mechanical ventilation patterns and trends over 20 years in an Israeli hospital system: Policy ramifications. *Isr J Health Policy Res* 2019; 8 (1): 1-10.
10. Lone NI, Walsh TS. Prolonged mechanical ventilation in critically ill patients: Epidemiology, outcomes and modelling the potential cost consequences of establishing a regional weaning unit. *Crit Care* 2011; 15 (2): R102.
11. Nelson JE. Chronic Critical Illness. *Am J Respir Crit Care Med* 2010; 182: 43-54.
12. Cox CE, Carson SS, Lindquist JH, Olsen MK, Govert JA, Chelluri L. Differences in one-year health outcomes and resource utilization by definition of prolonged mechanical ventilation: A prospective cohort study. *Crit Care* 2007; 11 (1): 1-11.
13. Engoren M, Arslanian-Engoren C, Fenn-Buderer N. Hospital and long-term outcome after tracheostomy for respiratory failure. *Chest* 2004; 125 (1): 220-7.
14. Damuth E, Mitchell JA, Bartock JL, Roberts BW, Trzeciak S. Long-term survival of critically ill patients treated with prolonged mechanical ventilation: a systematic review and meta-analysis. *Lancet Respir Med* 2015; 3 (7): 544-53.
15. Anzueto A, Anzueto A, Frutos F, et al. Characteristics and outcomes in adult patients receiving mechanical ventilation. *JAMA* 2002; 287 (3): 345-55.
16. Pandian V. Predictors of short-term mortality in patients undergoing percutaneous dilational tracheostomy. *J Crit Care* 2012; 34 (5): 880-6.
17. Nelson JE, Tandon N, Mercado AF, Camhi SL, Ely EW, Morrison RS. Brain dysfunction: another burden for the chronically critically ill. *Arch Intern Med* 2006; 166 (18): 1993-9.
18. Siegel RE, Nelson JE, Litke A, Morrison RS, Natale DA, Meier DE. The symptom burden of chronic critical illness. *Crit Care Med* 2004; 32 (7): 1527-34.
19. Utah Health Status Survey. Interpreting the SF-12. *Health (San Fr)* 2001;17. [Available from: http://health.utah.gov/opha/publications/2001hss/sf12/SF12_Interpreting.pdf].
20. Bentur N, King Y. The challenge of validating SF-12 for its use with community-dwelling elderly in Israel. *Qual Life Res* 2010; 19 (1): 91-5.
21. Hersch M, Izbicki G, Dahan D, Breuer GS, Nesher G, Einav S . Predictors of mortality of mechanically ventilated patients in internal medicine wards. *Journal of Critical Care* 2012; 27: 694-701.

Capsule

Immunology through a human lens

The coronavirus disease-2019 (COVID-19) pandemic has underscored the critical need to better understand the human immune system and how to unleash its power to develop vaccines and therapeutics. Much of our knowledge of the immune system has accrued from studies in mice, yet vaccines and drugs that work effectively in mice do not always translate into humans. **Pulendran** and **Davis** reviewed recent technological advances that have facilitated the study of the immune system in humans. They discussed new insights and how these can affect the development of drugs and vaccines in the modern era.

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