

Research article

Resource utilisation and description of patients perceived as receiving inappropriate critical care

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ABSTRACT

Objective: Medical interventions that do not offer the patient meaningful benefit due to inconsistency with prognoses are often considered “inappropriate” by clinicians. We described the clinical details and resource utilisation of patients who were assessed as receiving inappropriate treatment.

Design: Chart abstraction was performed on 123 patients who were assessed by their critical care physician as having received inappropriate treatment to document clinical characteristics, diagnostic testing, life-sustaining treatments and nursing assessments of daily pain and level of consciousness.

Results: The mean age was 67 and on admission, 41% had cancer and 25% had advanced pulmonary disease. At least one of the following three conditions was noted in 57% of the patients: severe neurological injury, overwhelming sepsis or irreversible respiratory failure. Patients were less likely to be alert (OR 0.39, CI 0.16–0.91, $p = 0.03$) on days they were assessed as receiving inappropriate critical care. After they were assessed as receiving inappropriate critical care, they received 172 imaging studies, 151 procedures, 522 days of mechanical ventilation (excludes one patient who received 1020 days of mechanical ventilation), 254 days of vasopressors, 226 days of hemodialysis and 10 attempts at cardiopulmonary resuscitation.

Conclusions: Patients assessed as receiving inappropriate critical care receive resource-intensive medical care, largely while non-alert.

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Implications for clinical practice

- This study provides a characterisation of patients for whom critical care was perceived to be inappropriate, including their daily pain, level of consciousness and the tests and treatments they received after they were assessed as receiving inappropriate critical care.
- Patients who were assessed as receiving inappropriate critical care received resource intensive and burdensome treatments.
- Level of consciousness is important in a clinician's assessment as to whether the aggressive critical care will lead to meaningful benefit.

Introduction

In the United States, one in five Americans die following an intensive care unit (ICU) admission and nearly half of the patients who die in a hospital receive intensive care, leading to increased

scrutiny of the ICU as a setting where potentially inappropriate, resource-intensive treatment is provided (Angus et al., 2004; Esserman et al., 1995; Wunsch et al., 2009). Inappropriate treatment, defined here as treatment that does not offer the patient meaningful benefit due to inconsistency with their prognosis, is a recognised phenomenon in the ICU (Anstey et al., 2015; Huynh et al., 2013; Palda et al., 2005; Piers et al., 2011; Singal et al., 2014). A survey of ICU physicians found that 87% felt that “futile” treatment was provided in their ICU in the past year (Palda et al., 2005). In another study, 27% of 1651 interviewed ICU physicians

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and nurses stated that on the interview day they treated at least one patient who received disproportionate care, most of which were excessive (Piers et al., 2011). Aggressive life-sustaining treatments that do not lead to meaningful benefit are not only unbeneficial for the patient, but also resource-intensive. Between 2000 and 2010, annual critical care costs have nearly doubled from \$56 to \$108 billion annually and these costs account for 1% of the GDP in the US (Halpern et al., 2016; Halpern and Pastores, 2015). The US spends considerable more resources for the provision of critical care than other countries (Angus et al., 1997; Wright et al., 2016).

No study to date has described the patients who are perceived by critical care physicians to be receiving inappropriate ICU treatment, including day-to-day clinical status and resource use. In this study, we provide clinical descriptions of these patients who were previously identified in the parent study (Huynh et al., 2013), including their daily pain, level of consciousness, and the tests and treatments they received after they were assessed as receiving inappropriate critical care. Level of consciousness and pain are assessments documented by the bedside nurse. Because prior work has suggested that nurses are privy to an additional perspective as to why ICU treatment may be non-beneficial (Neville et al., 2015), these real-time nursing assessments may help us better understand who these patients are. We aimed to characterise these patients by describing their clinical status, whether they were conscious, in pain, connected to machines and receiving invasive and non-invasive studies.

Methods

The definition of inappropriate treatment and the core data collection are described in detail elsewhere and summarised here (Huynh et al., 2013). This study was approved by the institutional review board (IRB# 11-002942-CR-00004). Based on a focus group discussion with physicians who cared for critically ill patients, a questionnaire was developed to identify patients perceived as receiving inappropriate critical care. For each ICU patient under their care, the attending physician completed a questionnaire asking whether they perceived that the patient was receiving inappropriate treatment, receiving probably inappropriate treatment or receiving appropriate treatment. Every day from December 15, 2011 through March 15, 2012, research assistants administered the questionnaire to each attending critical care specialist providing treatment in five ICUs in the academic health system. Based on these data, patients were categorized into three groups: patients for whom treatment was never perceived as inappropriate; patients with at least one assessment that treatment was probably inappropriate, but no assessments of inappropriate treatment; and patients with at least one assessment of inappropriate treatment. Hospital and 6-month mortality were abstracted for each group.

Medical Record Abstraction. Nurses used a detailed medical record abstraction tool to abstract clinical details and characterize the hospital course for each of the 123 patients who were assessed as receiving inappropriate treatment. The medical record abstraction collected underlying medical conditions, nurse assessments of level of consciousness (LOC) and pain, life-sustaining treatments, and resource utilisation. Abstractors recorded the worst pain score and the highest LOC each day, starting from three days prior to the first date the patient was assessed as receiving inappropriate or probably inappropriate treatment. LOC was dichotomized to alert or not alert (states included lethargic, stuporous, comatose, responsive to tactile stimuli only, responsive to pain only, or unresponsive/comatose) for statistical analysis. Pain was rated on a 0–10 scale or that the nurse was “unable to assess.” Pain scores of 1–5 were considered mild-moderate pain and pain scores of 6–10 were considered moderate-severe pain.

Abstractors also documented the dates when patients were started on and removed from mechanical ventilation, vasopressors, and hemodialysis throughout their hospitalisation. Episodes of cardiopulmonary resuscitation were recorded. All imaging studies, procedures, and transfusions with their dates were recorded. The timing of family meetings and ethics and palliative care consultations were also abstracted.

Data Analysis. For each of the 123 patients, patient status and resource utilisation information was merged with daily assessments of appropriateness of care. Bivariate analysis was used to detect differences in pain and LOC on days when the patient was perceived as receiving appropriate critical care versus days when they were perceived as receiving inappropriate critical care. For simplicity, days in which patients received *probably* inappropriate treatment were dropped from this analysis. To account for non-independence arising from repeated assessments per patient, bivariate analyses were Wald chi-square tests from binary or multinomial logistic regression and t-tests from linear regressions, respectively, with clustered standard errors. A multivariate logistic regression model, also with clustered standard errors, with an interaction term for pain and LOC was generated for days in which both a pain level (1–10) and LOC were documented (neither missing nor not assessed). Days of life-sustaining treatments *after* a patient had been assessed as receiving inappropriate treatment were summed. Resource utilisation was totaled similarly. All analyses were performed with STATA, version 14.2 (StataCorp).

Results

During the 3-month study period, there were 6916 daily assessments made on 1136 patients. Of these 1136 patients, 904 (80%) patients were never assessed as receiving inappropriate critical care, 98 (8.6%) patients were assessed as receiving probably inappropriate critical care, and 123 (11%) patients were assessed as receiving inappropriate critical care. For patients who never received inappropriate critical care, the in-hospital mortality was 4.6% and the 6-month mortality was 7.3%. On the contrary, 68% of the patients who were assessed to have received inappropriate critical care died before hospital discharge and 85% died within 6 months and survivors remained in severely compromised health states (Huynh et al., 2013). For the 123 patients who received inappropriate critical care, there were 493 days assessed as appropriate, 370 days assessed as probably inappropriate, and 464 days assessed as inappropriate.

Table 1 shows the clinical characteristic of the 123 patients. The mean age was 67 (range 17–99) and 61% were male. Prior to admission, 19 (15%) patients were staying at a nursing home and 3 (2.4%) patients were at a long term acute care facility. Thirty (24%) patients were transferred from an outside hospital. On admission, 24% had advanced pulmonary disease, 7% had end-stage renal disease, 5% had congestive heart failure stage III/IV, 6% had end-stage liver disease, and 6% had severe dementia. Of the 51 (41%) patients who had cancer, 29 (58%) were described as having stage IV, metastatic, or relapsed disease, and lymphoma/leukemia was the most common malignancy (25%). Nine patients had a history of organ transplant. At least one of the following three conditions was noted in over 50% of the patients: severe neurological injury/permanently unconscious, overwhelming sepsis, or irreversible respiratory failure prior to an assessment of inappropriate critical care. Examples of patients assessed as receiving inappropriate critical care included the following:

- 44-year-old female with metastatic gastric cancer admitted with hematemesis, progressed to multi-system organ failure and died receiving multiple life sustaining treatments per family's preference;

Table 1

Characteristics of 123 patients who were assessed as receiving inappropriate critical care during a 3-month period in one health system.

	N (%)
Gender	
Male	75 (61%)
Female	48 (39%)
Age in years, median (range)	67 (17–99)
Source of Hospital Admission	
Emergency room	79 (64%)
Clinic	5 (4.1%)
Outside hospital transfer	30 (24%)
Home	8 (6.5%)
None of the above	1 (0.8%)
Prior living arrangement	
Home	99 (80%)
Skilled Nursing Facility	19 (15%)
Long-term acute care	3 (2.4%)
Homeless	1 (0.8%)
Other	1 (0.8%)
Clinical conditions on admission*	
Advanced pulmonary disease	30 (24%)
Renal disease requiring hemodialysis	9 (7.3%)
Congestive heart failure (Stage III or IV)	6 (4.9%)
End-stage liver disease	7 (5.7%)
Severe dementia	7 (5.7%)
Cancer	51 (41%)
Reason for ICU admission*	
Respiratory failure	67 (54%)
Hypotension	28 (23%)
Neurological catastrophe	31 (25%)
Bleeding	15 (12%)
Electrolyte abnormality	7 (5.7%)
S/p cardiac arrest	8 (6.5%)
Other	16 (13%)
Conditions noted prior to assessment of inappropriate treatment*	
Severe neurological injury/permanently unconscious	21 (17%)
No longer transplant candidate	8 (6.5%)
Not a surgical candidate	20 (16%)
Treatment clearly failed	9 (7.3%)
Overwhelming sepsis	25 (20%)
Irreversible respiratory failure	24 (20%)

*N not equal to 123 because patients may qualify for more than one category and not all patients fit into a listed category.

- 88-year-old female with congested heart failure admitted with stroke and refractory status epilepticus, received tracheostomy and gastrostomy tube during admission (unable to break status);
- 49-year-old female with end stage liver disease secondary to alcoholic cirrhosis who was admitted for a liver transplant evaluation but found not to be a transplant candidate and died with multi-system organ failure
- 73-year-old male with a history of prior cardiac arrest with anoxic brain injury and chronic ventilator-dependent respiratory failure admitted with septic shock

There were 620 days of inappropriate and probably inappropriate critical care where there was assessment of both pain and LOC. Of these 620 days, patients were alert for 238 (38%) days and non-alert for 382 (62%) days (Fig. 1). Among the 382 days non-alert, there were 264 (69%) days in which pain could not be assessed. For the 301 days that pain could be assessed, there were 38 (13%) days in which the patient experienced mild-moderate pain and 74 (25%) days were spent in moderate-severe pain. Bivariate analysis, which included up to 3 days of hospitalisation prior to an assessment of inappropriate or probably inappropriate critical care, showed that patients were significantly more likely to be non-alert on days where they were assessed as receiving inappro-

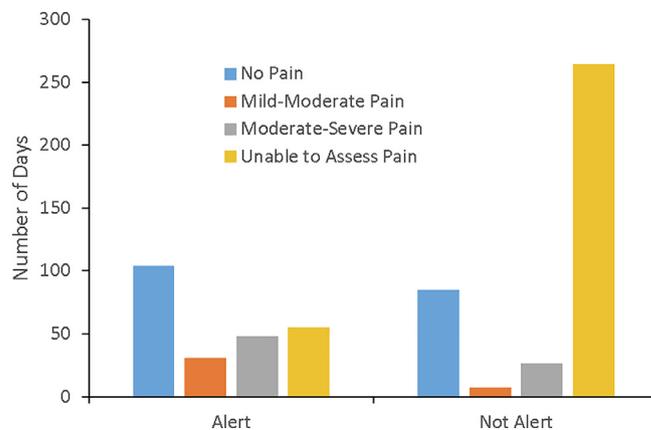


Fig. 1. Patient Level of Consciousness and Pain on Days Patient was Perceived as Receiving Probably Inappropriate or Inappropriate Critical Care (Non-Alert = lethargic, stuporous, comatose, responsive to tactile, responsive to pain, or unresponsive/comatose).

appropriate critical care compared to days when they were assessed as receiving appropriate critical care (73% versus 45%, p -value <0.001). Pain scores were not significantly different comparing days assessed as receiving inappropriate critical care to days receiving appropriate critical care. Multivariate analysis with an interaction term between LOC and pain confirmed that lower LOC, but not pain, was associated with patients being assessed as receiving inappropriate critical care (Table 2).

There was documentation of family meetings for 104 of the 123 patients who were assessed as receiving inappropriate critical care. Among patients with a family meeting, patients had a mean of 3.4 family meetings (SD 3.5) documented during the hospitalisation. Family meetings occurred on average 2.1 days after the ICU admission day and 8.5 days before the patient was assessed as receiving inappropriate critical care (some of these family meetings occurred before the patient was transferred to the ICU). Of the 123 patients, 14 (11.3%) received an ethics consultation (11 of 14 consultations were regarding limiting inappropriate critical care). Twenty-eight (23%) received a palliative care consultation and 10 (8.1%) were referred to hospice.

After these 123 patients were assessed as receiving inappropriate critical care, they spent 1542 days on mechanical ventilation, 254 days on vasopressors, and 226 days on hemodialysis (Table 3). There were several outliers, including a patient who received 1020 days of mechanical ventilation during her 3-year hospitalisation. Median utilisation for patients who were provided life-sustaining treatment after an assessment of inappropriate treatment was 4 days of mechanical ventilation, 3 days of vasopressors, and 6 days of dialysis. Nine patients underwent 10 cardiopulmonary resuscitation (CPR) attempts. After the assessment of inappropriate critical care, these 123 patients received 172 imaging studies, 151 invasive procedures and 546 transfusions. Five patients received chemotherapy and five received intravenous immunoglobulin (Table 4).

Table 2

Pain and level of consciousness association with assessment of inappropriate critical care.

	Odds Ratio	p-value	95% Confidence Interval
Level of consciousness	0.387	0.030	0.165–0.912
Pain	0.960	0.598	0.824–1.118
Level of consciousness-pain Interaction	0.973	0.757	0.819–1.156

Table 3
Life-sustaining treatment provided for 123 patients assessed as receiving inappropriate critical care.

Life Sustaining Treatment (LST)	Number of days on LST	Number of patients	Number of days on LST after an assessment of inappropriate critical care	Number of Patients
Mechanical Ventilation	2269	87	522*	64
Vasopressors	660	85	254	50
Dialysis	550	29	226	25
Cardiopulmonary resuscitation	27	21	10	9

First column shows the number of days on life-sustaining treatment during the entire hospitalisation for the 123 patients. The third column shows the number of days on life-sustaining treatment after the patient was assessed as receiving inappropriate critical care. *Excludes one patient who received 1020 days of mechanical ventilation during her 3-year hospitalisation.

Table 4
Resource utilisation by the 123 patients who were assessed as receiving inappropriate critical care.

Procedure	Number after patient assessed as receiving inappropriate treatment	Number of patients
Imaging Studies		
Computed Tomography	79	38
Ultrasound	46	25
Echocardiogram	30	24
MRI	12	10
Nuclear medicine test	5	3
Procedures		
Central venous catheter	22	18
PICC line	20	17
Dialysis line	23	15
Arterial line	13	11
IR-guided procedure	10	9
Bronchoscopy	15	9
Endoscopy	9	6
Gastrostomy tube	6	5
Tracheostomy	4	4
Surgery	7	4
Paracentesis	10	3
Temporary pacemaker	5	3
Lumbar puncture	2	2
Thoracentesis	3	2
Chest tube	1	1
Cardioversion	1	1
Infusions/Inhalations/Transfusions		
Packed red blood cells	244	48
Platelets	132	29
Fresh frozen plasma	170	17
Chemotherapy	5	3
Nitric oxide	28	3
IVIG	5	1
Granulocyte infusion	4	1
Amicar	18	1

PICC = Peripherally inserted central catheter, IR = interventional radiology, IVIG = Intravenous immunoglobulin.

Discussion

This is not the first study to demonstrate high resource utilisation in the ICU, particularly at the end-of-life (EOL) (Angus et al., 2004; Chaudhuri et al., 2017; Wunsch et al., 2009). Wunsch et al. described markedly higher rates of intensive care utilisation in the US compared to England (Wunsch et al., 2009), and Angus et al. predicted that the continued high ICU utilisation at the end of life will lead to critical care shortages in the near future (Angus et al., 2004). Chaudhuri et al. demonstrated that patients who utilise the ICU in proximity to death incur significant costs, more frequently die in the hospital, have longer lengths of stay, and receive more aggressive treatments such as CPR and feeding tubes (Chaudhuri et al., 2017). However, we believe that this is the first detailed characterisation of patients who were prospectively identified as receiving inappropriate critical care (of whom,

a majority die). We also report daily documentation of pain and LOC and the conditions that were noted on the day a patient was assessed as receiving inappropriate treatment, neither of which has not been previously characterised. Also, in comparison to the general ICU EOL patients discussed in the literature, a large percentage of whom are over age 80, (Angus et al., 2004; Chaudhuri et al., 2017), this cohort of patients is younger (median age 67), indicating that resource-intensive inappropriate critical care occurs across the spectrum of age.

The 123 patients in this study spent a considerable number of days receiving life-sustaining treatments during their ICU admission, often after they were assessed as receiving inappropriate critical care by their treating doctor. Furthermore, these patients underwent many diagnostic tests and procedures. These tests and procedures required the involvement and clinical expertise of many other clinicians, showing that such treatment affects many aspects of the health system outside of the ICU including radiologists, subspecialists of all sorts, numerous staff, and almost certainly involving many trainees. The physical transportation of a patient to a study outside of the ICU room alone requires a significant amount of coordination and effort from the bedside nurse. These diagnostic and “therapeutic” procedures were performed while the clinician in charge of their care assessed critical care to be inappropriate.

Nursing documentation suggests that most of these patients were not substantially suffering (i.e. it does not appear that the patients are under considerable pain, distress, or hardship). For nearly 3/4 of the days receiving inappropriate critical care, patients were not alert. When nurses were able to assess pain, the mean was 2.6 out of 10. There are two possible interpretations of this finding. It might indicate that a patient's level of consciousness is particularly important in a physician's assessment as to whether the aggressive critical care will lead to *meaningful* benefit. This suggests that critical care physicians, when defining treatment as inappropriate are focusing on prognosis and perhaps other factors such as the ability to meaningfully interact with one's surroundings. The finding that patients who were assessed as receiving inappropriate critical care were more often not alert might also indicate that these patients were sedated, perhaps because their discomfort had become hard to manage or because the dimming prognosis did not merit maintenance of alertness at the expense of suffering. Consistent with this is the finding that patients were more alert and had more pain when they were receiving appropriate critical care.

This analysis suggests that there is potential for significant cost savings and potential reduction in suffering if the aggressiveness of treatment were better matched with prognosis. But the question is how to do this. Simultaneous with the provision of critical care that the attending physician felt was inappropriate, there were extensive efforts to reorient care toward comfort during our study period as evidenced by the large number of documented family meetings. Furthermore, the first documented family meeting often occurred many days (on average 8.5 days) prior to an assessment

of inappropriate treatment, which suggests that perhaps physicians were striving to guide families towards prognosis-concordant care prior to the patient receiving the label of inappropriate critical care. However, palliative care (23%) and ethics consultations (11%) were scarce and might indicate missed opportunities for improved decision-making. Future interventions aimed at decreasing inappropriate critical care may benefit from automatic triggers for goals of care discussions and palliative care and ethics consultations for patients who are at risk for receiving inappropriate critical care. Our analysis also revealed that there was a considerable amount of heterogeneity in the amount of resource utilisation within this cohort of patients. Although any amount of resource utilisation in the ICU is significant, there may be further value in targeting patients who are at risk for receiving inappropriate critical care and excessive days of life-sustaining treatments and other interventions. Further research is necessary to evaluate whether this is possible.

Limitations

This small study has several limitations. The data are from one health system and the number of patients is small. The definition of inappropriate critical care is a clinical one, does not account for family perspectives and the exact content and quality of communication during family meetings are not known. Although the physician perspectives were prospective, the data for this report were collected retrospectively; we abstracted nurses' clinical recordings, which may be less precise and more likely to be missing than prospective data collected for research. Furthermore, the LOC recorded by nursing does not differentiate non-alert from sedation versus baseline neurological status (sedation scales are not routinely utilized). However, one might surmise that the requirement for sedation to the point of low LOC might indeed also be correlated with a physician's assessment of the patient's prognosis. Lastly, the extensive, detailed chart abstraction presented here was not performed for patients who were assessed as receiving appropriate treatment; therefore, it is not possible to evaluate whether resource utilisation, family meetings and consultations were related to an assessment of inappropriate critical care.

Conclusion

Despite these limitations, this is an important sample of patients who received hundreds of days of critical care and many procedures. These patients, largely unawake, receive extensive resource use. Furthermore, studies have revealed that the aggressiveness of care for patients, particularly those with cancer, at the EOL have increased over time (Mrad et al., 2018; Wang et al., 2016). This suggests that high resource utilisation with little meaningful clinical outcome will continue to be a relevant issue. Perhaps putting a face on patients receiving inappropriate critical care can foster and inform a public discussion about improving transitions for patients in the ICU for whom medicine is overmatched by their disease.

Ethical Approval

This study was approved by the UCLA institutional review board (IRB# 11-002942-CR-00004).

Declaration of Competing Interest

None of the authors above have conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.iccn.2019.06.003>.

References

- Angus, D.C., Barnato, A.E., Linde-Zwirble, W.T., Weissfeld, L.A., Watson, R.S., Rickert, T., et al., 2004. Use of intensive care at the end of life in the United States: an epidemiologic study. *Crit. Care Med.* 32, 638–643.
- Angus, D.C., Sirio, C.A., Clermont, G., Bion, J., 1997. International comparisons of critical care outcome and resource consumption. *Crit. Care Clin.* 13, 389–407.
- Anstey, M.H., Adams, J.L., McGlynn, E.A., 2015. Perceptions of the appropriateness of care in California adult intensive care units. *Crit. Care* 19, 51.
- Chaudhuri, D., Tanuseputro, P., Herritt, B., D'Egidio, G., Chalifoux, M., Kyeremanteng, K., 2017. Critical care at the end of life: a population-level cohort study of cost and outcomes. *Crit. Care* 21, 124.
- Esserman, L., Belkora, J., Lenert, L., 1995. Potentially ineffective care. A new outcome to assess the limits of critical care. *JAMA* 274, 1544–1551.
- Halpern, N.A., Goldman, D.A., Tan, K.S., Pastores, S.M., 2016. Trends in critical care beds and use among population groups and medicare and medicaid beneficiaries in the United States: 2000–2010. *Crit. Care Med.* 44, 1490–1499.
- Halpern, N.A., Pastores, S.M., 2015. Critical care medicine beds, use, occupancy, and costs in the United States: a methodological review. *Crit. Care Med.* 43, 2452–2459.
- Huynh, T.N., Kleerup, E.C., Wiley, J.F., Savitsky, T.D., Guse, D., Garber, B.J., et al., 2013. The frequency and cost of treatment perceived to be futile in critical care. *JAMA Intern. Med.* 173, 1887–1894.
- Mrad, C., Abougergi, M.S., Daly, B., 2018. One step forward, two steps back: trends in aggressive inpatient care at the end of life for patients with stage IV lung cancer. *J. Oncol. Pract.*, JOP1800515
- Neville, T.H., Wiley, J.F., Yamamoto, M.C., Flitcraft, M., Anderson, B., Curtis, J.R., et al., 2015. Concordance of nurses and physicians on whether critical care patients are receiving futile treatment. *Am. J. Crit. Care* 24, 403–410.
- Palda, V.A., Bowman, K.W., McLean, R.F., Chapman, M.G., 2005. "Futile" care: do we provide it? Why? A semistructured, Canada-wide survey of intensive care unit doctors and nurses. *J. Crit. Care* 20, 207–213.
- Piers, R.D., Azoulay, E., Ricou, B., Dekeyser Ganz, F., Decruyenaere, J., Max, A., et al., 2011. Perceptions of appropriateness of care among European and Israeli intensive care unit nurses and physicians. *JAMA* 306, 2694–2703.
- Singal, R.K., Sibbald, R., Morgan, B., Quinlan, M., Parry, N., Radford, M., et al., 2014. A prospective determination of the incidence of perceived inappropriate care in critically ill patients. *Can. Respir. J.* 21, 165–170.
- Wang, S.Y., Hall, J., Pollack, C.E., Adelson, K., Bradley, E.H., Long, J.B., et al., 2016. Trends in end-of-life cancer care in the Medicare program. *J. Geriatr. Oncol.* 7, 116–125.
- Wright, A.A., Keating, N.L., Ayanian, J.Z., Chrischilles, E.A., Kahn, K.L., Ritchie, C.S., et al., 2016. Family perspectives on aggressive cancer care near the end of life. *JAMA* 315, 284–292.
- Wunsch, H., Linde-Zwirble, W.T., Harrison, D.A., Barnato, A.E., Rowan, K.M., Angus, D.C., 2009. Use of intensive care services during terminal hospitalisations in England and the United States. *Am. J. Respir. Crit. Care Med.* 180, 875–880.